AN AVALANCHE CHARACTERIZATION CHECKLIST FOR BACKCOUNTRY TRAVEL DECISIONS

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ABSTRACT: This paper presents a checklist to assess the character of likely avalanche activity for the purpose of backcountry travel decisions. The purpose of the checklist is to help bridge the gap between stability assessment and risk management decisions about travel on specific terrain features. The checklist expresses the character, and to some extent the spatial variability, of snowpack instability rather than the likelihood of avalanche occurrence.

There is inherently less uncertainty about the type of avalanches likely to occur than about the probability of triggering avalanches on specific terrain features. However, assessing the character of possible avalanches is even more relevant than assessing the ease of triggering avalanches when managing the risk of travel in backcountry terrain.

The checklist is proposed as a method for professional guides and experienced recreationists to help communicate their subjective thought processes and to provide structure for assessing the character of potential avalanche activity. Avalanche activity is separated into different regimes, and potential for avalanches in each regime is then assessed. Examples of "avalanche regimes" include "Wind Slabs Near Ridge tops", "Glide Avalanches", etc.

The motivation for this checklist comes from my observations during decades of work as a helicopter ski guide in western North America. This is a practitioner's viewpoint inspired by the increasing wisdom of backcountry travelers and improved means of communication. The intent of the checklist is to better express our snowpack instability concerns in a systematic way that is meaningful for backcountry risk management.

Keywords: avalanche, characterization, checklist,

1. INTRODUCTION

The motivation behind this paper is that I perceive a need for improved communication of the complexities, the subtleties, and the subjective aspects of our perception of snow stability. Our work environment has evolved such that we now work more as teams than as individuals and we use information sharing between organizations to enhance our perception of conditions and improve our decision making, but we do not have a systematic way to express the complexities and subtleties of our perception of the conditions. The traditional stability assessment can only do this if we do a good job of adding narrative comments, and this cannot be expected every day from a hundred different groups, when each group is composed of people with a diverse background, varying language skills, different styles of expression, different mandates, etc.

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At this time, the entire process of dissemination of avalanche information to the public and the common view of the decision making process are being re-evaluated in Canada. There is an effort is to reach a bigger audience with very basic messages about avalanche danger that are easy to understand and do not require the background needed to interpret a complete avalanche bulletin. There is also a need at the other end of the scale to provide a format with a greater level of detail for very skilled travelers, and something like the avalanche characterization checklist might be useful for this. Having a multi-tiered bulletin like this makes it apparent that there is more to be learned and encourages continuing education without marginalizing those with less experience and training.

The checklist is not currently used as an operational process, and is not necessarily intended to become one. It is intended as a suggested format to summarize the complexity behind stability evaluations in a manner that is meaningful for backcountry terrain selection.

Communication is a two part process, ideas need to be expressed clearly but communication is not complete until the message is received and interpreted correctly (more or less). Even though the writers of public bulletins have become very good at crafting narrative descriptions of conditions, it is likely that many readers focus on the danger ratings and miss the significance of the narrative. Perhaps a format such as the avalanche characterization checklist would communicate more clearly to more people.

This paper is written from the perspective of avalanche work in western Canada, but there are probably similar issues in other parts of the world.

2. BACKGROUND ANALYSIS

Canadian Mountain Holidays (CMH) operates thirteen separate helicopter skiing areas covering a large geographic area in the Columbia mountain ranges of interior British Columbia. Each CMH area is over one thousand square kilometers, and each area has more than two hundred named ski runs An individual ski run can be a large and complex piece of terrain and many individual 'ski runs' cover an area as large as a major ski resort.

There are typically five guides working as a team in each of the CMH areas at any time. Before skiing in the morning, the guiding team works together to make a stability assessment for the day based on all available observations. These observations include local weather, snowpack, and avalanche occurrence observations as well as observations and assessments made by other avalanche professionals throughout western Canada. Information from other operations is accessed through the Canadian industry information exchange (Infoex).

Snow stability is assessed for three vegetation bands, 'Alpine', 'Treeline', and 'Below Treeline'. The Canadian Avalanche Association Observation Guidelines and Recording Standards for Weather, Snowpack, and Avalanches (CAA, 2002) defines a five point scale for stability assessment with values of 'Very Good (VG), Good (G), Fair (F), Poor (P), and Very Poor (VP). This stability rating differs from the international danger scale rating used in public avalanche bulletins in that the stability rating assesses only the stability of the snow and contains no information about the character of likely avalanches, while the international danger scale does incorporate some consideration of the consequences of triggering avalanches. In both cases, it is necessary to refer to the narrative portion of the stability assessment for information about the character of likely avalanches.

After the stability assessment is completed, the guiding team then considers the ski runs. A run list is made on which the runs may be coded as 'Green' (open for guiding) or 'Red' (closed to guiding for the day). Some terrain on runs that are open for guiding may still have avalanche potential, but the assessment is that it is possible to use route selection to manage the risk of taking groups skiing on that terrain.

A few runs may also be coded as 'Yellow', which means that the run is available for guiding only if specific conditions are met, such as if the overhanging cornices have already fallen off. Some runs will not be discussed, and undiscussed runs are not available for guiding.

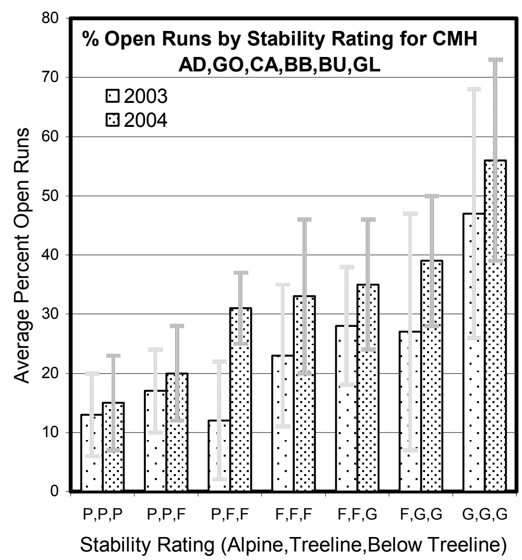

Figure 1: Data from CMH heli-ski areas shows the average percentage of open runs grouped by stability rating. The guides consistently opened more runs in 2004 than they opened under the same stability rating in 2003.

In western Canada, the winters of 2003 and 2004 were very different. 2003 was characterized by multiple deep, persistent instabilities producing large destructive avalanches over the course of the entire season while 2004 was characterized by an almost complete absence of persistent weak layers. Data from CMH heli-ski areas were analyzed for terrain selection vs. stability rating during the period between January first and March fifteenth of these two winters. These data are from six guiding teams working in the Adamants (AD), Gothics (GO), Cariboos (CA), Bobbie Burns (BB), Bugaboos (BU), and Galena (GL). These data represent the collective judgment of approximately fifty guides working in six teams of five at any time. The percentage of runs assessed as 'Green' (open for guiding) was calculated for each day in each operation, for a total of 651 samples. The average percentage of open runs on days with the same stability rating was computed for each year. Figure 1 shows a comparison of the percentage of open runs by stability rating for the two seasons.

These data show a general trend to open more terrain on days with better stability ratings. That is comforting and expected. These data also show a significant variation in the percentage of open runs on days with the same stability rating, as shown by the standard deviations plotted as error bars in Figure 1. And, for every stability rating, the average percentage of open runs was greater in the 2004 winter than in the 2003 winter. There were consistently more open runs in 2004 than in 2003 under the same stability ratings. Grouping days by regional public bulletin danger rating instead of local stability rating gives similar results.

3. A CASE STUDY

In the more extreme examples, the percentage of open runs can be as high as 85% or as low as 30% under the same stability ratings.

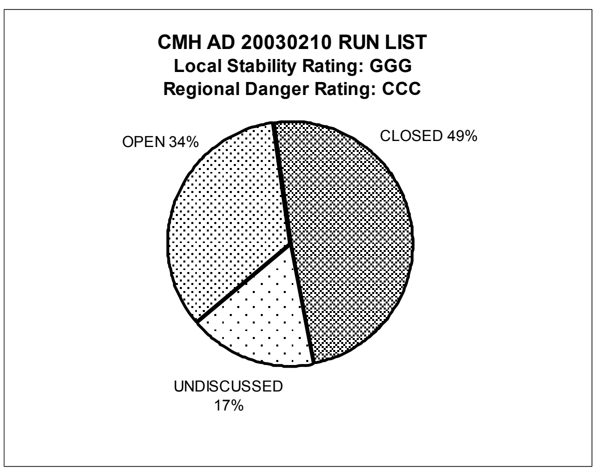

FIGURE 2: The percentage of open, closed, and undiscussed ski runs is shown for CMH Adamants on February 10, 2003. The local stability rating was "GOOD" and the regional danger rating was "CONSIDERABLE" for alpine, treeline, and below treeline areas.

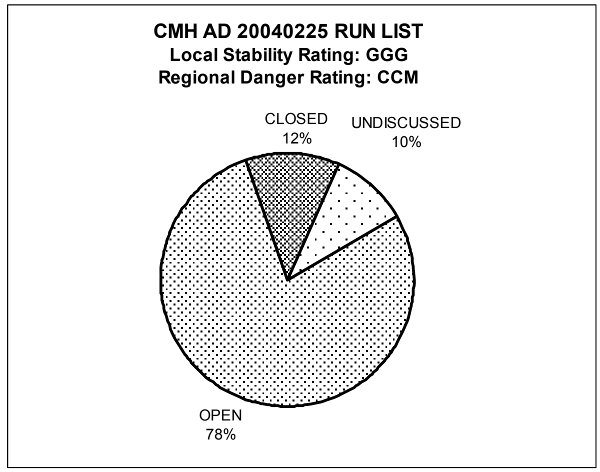

FIGURE 3: The percentage of open, closed, and undiscussed ski runs is shown for CMH Adamants on February 25, 2004. The local stability rating was "GOOD" and the regional danger rating was "CONSIDERABLE" for alpine and treeline areas; the local stability rating was 'GOOD" and the regional danger rating was "MODERATE" for below treeline areas.

Figure 2 and Figure 3 summarize the CMH Adamants run lists from two days with same stability rating but very different terrain selection. The regional danger scale rating was also very similar on these two days. Only the below treeline danger rating was different; both days were rated "CONSIDERABLE" in alpine and treeline areas and one day rated "CONSIDERABLE" and the other rated "MODERATE" below treeline.

Neither the local stability ratings nor the regional danger ratings differentiate these two days and there is nothing in the guides' comments to account for the difference in terrain selection, but more than twice as many ski runs were open on February 25, 2004 than on February 10, 2003.

It is possible to search back through the collective observations of the guides and piece together the snowpack concerns that differentiate these two days.

In this case, the narrative of the regional avalanche bulletin does describe conditions that explain the difference in terrain selection. The regional public bulletin from February 10, 2003 includes the following statements: *"Some observations such as strengthening shear tests and a lack of avalanche activity may be pointing towards better stability. However, we have to look less at those observations and more at the history* *of this season's weak layers. We know that this winter, even on seemingly stable slopes thin areas can be zones of very weak snow, waiting for a human or natural trigger. Slight triggers have propagated enormous avalanches as recently as last weekend. The consequences (danger) of these large avalanches are something to be avoided."* On the same day, the only comment recorded by the guides in the Adamants was a succinct "*Surface hoar and sun crusts, surface faceting continues*". No mention was made of the deep instabilities plaguing everyone throughout the season because it was assumed that the professional community was acutely aware of the problem and it did not need to be re-stated daily.

The following statements taken from the regional bulletin for February 25, 2004 describe very different considerations even though the danger ratings were similar: "*A weak surface hoar layer buried on Valentines Day is 20-40 cm deep and remains reactive to human triggering. Expected new snow, accompanied by enough wind to concentrate it in lee areas, will increase the stress on this important layer—primarily on northwest through east facing slopes. The deeper snowpack is generally strong; however, a crust/facetted snow combination buried 75 cm deep continues to be watched by snow professionals, especially in areas with thin snow cover.*" Guides in the Adamants recorded the following statement on this day: "*10 cm of new snow over the past 24 hours overlies surface hoar and/or sun crust. Winds have formed soft slabs at ridge top and isolated areas in the alpine. Up to 40 cm over 040214 surface hoar at treeline, reacting easy to moderate in snowpack tests. Extensive ski cutting with no results*".

As these examples illustrate, regional public bulletins generally contain more complete and consistent text descriptions of conditions than the comments from stability evaluations made by other avalanche professionals, but even the bulletins show inconsistency in this regard. Important messages are sometimes easy to overlook within the text of the bulletin.

The stability evaluation alone does not suggest much difference in terrain selection, but the difference in terrain selection on these two days makes sense when viewed in the context of the different character of avalanches likely to occur on these two days. "Information without context leads to ill-informed decision making" – Ken Little, Meteorological Services of Canada (MSC)

The avalanche characterization checklist puts the terrain decisions into the context of the overall situation in the snowpack, and an avalanche characterization checklist completed for each of these sample days would explain the difference in terrain selection at a glance.

Snow avalanches encompass a myriad of different events with the common theme being that all avalanches involve snow moving down the mountain. Examining the historical record shows that terrain use was different in 2003 than in 2004 under similar stability conditions. Good stability in 2004 was treated very differently than good stability in 2003, and the same is true for Fair and Poor stability. The difference is not in the ease of triggering avalanches, but is in the character of the avalanches that are likely if triggering does occur.

4. CRITERIA FOR CATEGORIES

The criteria used for the avalanche characterization checklist is to define avalanche regimes that require different risk management strategies now or in the future days/weeks/months and/or avalanche regimes that imply spatial distribution or terrain type for avalanche potential. The categories are not normalized; it is possible for an avalanche to belong to multiple regimes. Some categories are quite broad and general, others refer to a specific condition and may imply a specific strategy for risk management.

I have proposed a fairly comprehensive checklist backcountry ski guiding operations in western North America. Different categories could be more appropriate for other types of operations or other geographic locations, but the same basic concepts still apply. There is no need for a single universal checklist.

Avalanche size is referred to as 'Super-Sized', 'Large', 'Mid-Sized', 'Small' or 'Very Small'. The size references are interpreted approximately as follows:

Super-Sized	Beyond Historic Paths
Large Destructive	Size > 3
Mid-Sized	Size 2 to 3
Small	Size 1 to 1.5
Very Small	Size < 1

5. THE CHECKLIST:

AREA:_____________________________ **DATE:**_________________

	Unlikely	Possible	Likely
Persistent Instabilities			
Super-Size Slab Avalanches (Running Beyond Historic Paths)	☐	☐	☐
Large Dry Deep Slab Avalanches on Basal Persistent Weak Layers	☐	☐	☐
Large Dry Deep Slab Avalanches on Mid-pack Persistent Weak Layers	☐	☐	☐
Mid-Sized Slab Avalanches on Mid-pack Persistent Weak Layers	☐	☐	☐
Small Dry Slab Avalanches on Near Surface Persistent Weak Layers	☐	☐	☐
Slab Avalanches on Extra Low Angle Terrain	☐	☐	☐
Remote Triggering	☐	☐	☐
Storm Instabilities			
Large Slab Avalanches in Storm Snow	☐	☐	☐
Mid-Sized Slab Avalanches in Storm Snow	☐	☐	☐
Small Slab Avalanches in Storm Snow	☐	☐	☐
Deep Dry Sloughing (‘Running Fast and Far’)	☐	☐	☐
Wind Slabs			
Widespread Wind Slabs	☐	☐	☐
Wind Slabs Near Ridge Tops	☐	☐	☐
Katabatic Wind Slabs	☐	☐	☐
Hidden (buried) Wind Slabs	☐	☐	☐
Hard Wind Slabs	☐	☐	☐
Surface Instabilities			
Very Small Dry Surface Slabs	☐	☐	☐
Very Small Wet Surface Slabs	☐	☐	☐
Dry Surface Sloughing	☐	☐	☐
Wet Surface Sloughing	☐	☐	☐
Wet Avalanches			
Large Wet Slab Avalanches	☐	☐	☐
Mid-Sized Wet Slab Avalanches	☐	☐	☐
Small Wet Slab Avalanches	☐	☐	☐
Wet Sloughing	☐	☐	☐
Glide Avalanches	☐	☐	☐
Cornice Failures	☐	☐	☐
Ice Falls	☐	☐	☐

Comments:

6. ASSESSMENT OF EACH CATEGORY

For each category, there is a check box for 'Likely', 'Possible', and 'Unlikely'. These are subjective categories and do not correspond to stability evaluations of the ease of triggering. Rather, these express a level of concern based mainly on how widespread the instability is, perhaps influenced by the ease of triggering. These terms can be interpreted as follows:

LIKELY: Avalanches in this category can be triggered on many terrain features capable of producing avalanches of this type.

POSSIBLE: Avalanches in this category can be triggered on a few terrain features capable of producing avalanches of this type.

UNLIKELY: Avalanches in this category are anomalies and can only be triggered in very isolated locations.

Comments are still used to expand on aspects of the instability, such as the spatial distribution or details of the avalanche behavior.

7. DISCUSSION

The complexity of snow stability is that there are multiple instabilities on different layers within the snowpack, each instability can exhibit extreme spatial variability, all instabilities change over time, the temporal changes of the instabilities also exhibit spatial variability, and each instability produces avalanches of different character.

Spatial variability has both random and systematic components. The systematic component of spatial distribution is related to the character of the instability. Similarly, temporal changes in the distribution of instability are related to the character of the instability (e.g. springtime diurnal cycles or the patterns of stabilization rates for different weak layers).

The decision to ski on a specific terrain feature is either based on specific knowledge of the current snowpack characteristics on that terrain (e.g. the slope has previously failed on the layer of concern) or it is based on an assessment of general snowpack conditions and what that means for that terrain. An assessment based on the general snowpack conditions can leave a great deal of uncertainty about the stability of the snow on a specific terrain feature, but there is often much less uncertainty about the character of the avalanches that might result if the slope does fail.

Stability assessments made by guides and avalanche workers (other than public bulletin forecasters) often include very little information about the character of the instability. To interpret these stability assessments, the character of the instability is implicitly assumed based on the context of the snowpack structure at the time, but is often not stated explicitly. There is very little misinterpretation between professionals working consistently in a region because they have intimate knowledge of the history of the season and the resulting snowpack structure. However, there is potential for misinterpretation when stability assessments are taken out of context or interpreted by people who are not highly skilled and familiar with the terrain and current conditions.

A small group of forecasters can develop excellent skills at producing text describing subtle and complex aspects of snow stability while a large number of guides cannot be expected to express themselves consistently in narrative. The central objective of the guides is to manage backcountry travel; written expression of thoughts about snow stability is secondary. In contrast, the central objective of the forecasters is to communicate conditions. Ultimately, the product of a guide's work is a collection of terrain decisions while the product of a bulletin forecaster's work is the assessment and communication of conditions.

Additionally, there is a tremendous diversity of background in the larger guiding community, including cultural and linguistic differences that affect the consistency of written statements about snow stability. Individual guides reach similar decisions even though they may use different thought processes and may express their reasoning very differently. When guides work in a team, it is much easier to reach consensus about terrain management than about stability ratings, and it is much harder still to reach consensus about the exact wording in a narrative description of conditions.

8. CONCLUSIONS

There are aspects of snow stability that are very important for backcountry terrain management decisions and which cannot be expressed in a snow stability rating or a danger scale rating without additional detail. Much of this detail relates to the character of likely avalanche activity, and we rely on the text portion of the stability evaluation to communicate these considerations.

Stability evaluations made by avalanche workers lack consistent narrative expressing important subjective assessments about snow stability and the character of avalanches that are likely to occur. Public avalanche bulletins are more consistent than stability evaluations from other avalanche workers, but the text in public bulletins is not always comprehensive and the reader's skill at interpreting the narrative portion of the bulletins is uncertain.

The avalanche characterization checklist gives structure to the assessment and expression of the character of instability. The checklist allows avalanche workers to quickly and consistently summarize meaningful detail that is frequently not expressed in stability evaluations and public avalanche bulletins.

Snow safety programs enjoy increased information sharing between operations in recent years, but essential thinking about the snow stability is often not communicated. Subjective assessments are difficult to express but contain valuable information that cannot be communicated by objective measurements and stability ratings alone. A complete expression of snowpack instability includes an assessment of ease of triggering, an assessment of spatial variability, an assessment of trend, and an assessment of the character of avalanches likely to occur as a result of that instability.

Evaluating the character of likely avalanche activity leads directly to implications about how best to manage terrain. Spatial variability has two components: random variability and systematic variability. An assessment of the character of likely avalanche activity gives some insight into the systematic component of the spatial variability. An assessment of the character of likely avalanche activity also gives some insight into how that instability is likely to respond over time as the meteorological history of the winter unfolds. For any specific terrain feature, the character of likely avalanche activity can be assessed more reliably than the probability of triggering an avalanche. An assessment of the character of likely avalanche activity is a key link in the chain between stability evaluation and terrain management.

We, as guides and avalanche field workers, are not consistently articulate at expressing our snowpack concerns in written statements. Compared to public bulletin forecasters, teams of guides from diverse backgrounds cannot be expected to be especially adept at producing these written statements on a regular basis. The avalanche characterization checklist systematically summarizes the subjective assessment of the character of likely avalanche activity in a concise and consistent manner for communication between practitioners of diverse backgrounds.

An increase in the resolution of the stability rating system or any achievable increase in the accuracy of the stability assessment translates into little, if any benefit for terrain management, but an increase in awareness of the character and distribution of likely avalanche activity does directly translate to improved terrain management. Even if we go to ten stability rating levels and improve accuracy, then little benefit is gained for terrain management even with great effort. In contrast, a relatively small effort to improve the assessment and communication of the character of the instability does have significant benefits

As stated earlier, this is not used anywhere as an operational tool. I developed it more with the intent of illustrating a point than with the intent of promoting it as a methodology. However, in the process I was somewhat surprised that this checklist method shows more promise for operational use than I originally thought. I am not on a crusade to impose this method, but I am curious to experiment with it in my own work and to explore the reaction of my immediate co-workers this coming season. If the results are positive, then perhaps a refinement of this checklist will eventually be used operationally.

9. ACKNOWLEDGEMENTS

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10. REFERENCES

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