# THE ROLE OF AVALANCHE CHARACTER IN PUBLIC AVALANCHE SAFETY PRODUCTS

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ABSTRACT: Avalanche character is a significant factor in professional decision-making (Atkins, 2004). Weak layer/interface, slab properties, persistence, weak layer location, propagation propensity, and relative size (Statham *et al.*, 2010) play an important role in how risk management decisions, such as terrain selection and timing, are implemented in the field. In recent years, avalanche character has become an essential component of Canadian public avalanche forecasts, along with its inclusion in standardized recreational avalanche training curricula, and in decision making tools such as the Avaluator V2.0 (Haegeli, 2010) and the Decision Making in Avalanche Terrain Fieldbook (Haegeli, Atkins & Klassen, 2010a).

This paper reviews the current avalanche character definitions and suggests improvements and refinements. Current usage is reviewed and potential new applications are explored. Recommendations are provided for public avalanche safety agencies that do not currently use avalanche character but who are considering incorporating avalanche character into their products or services.

## 1. INTRODUCTION

In his seminal paper at the ISSW in 2004, Roger Atkins proposed that professional heli-skiing guides' perception of risk is strongly influenced by the characteristics of expected avalanches regardless of the present stability ratings (Atkins, 2004). Atkins presented a list of 27 avalanche scenarios (e.g., widespread wind slabs, mid-sized slab avalanches in storm snow) and discussed a distinct risk mitigation approach for each of these scenarios. He concluded that the description of the character of the current avalanche scenario is crucial for effective communication of avalanche hazard, both among avalanche professionals and in public avalanche safety products.

At the same time, similar thoughts were explored by the Swiss guiding community. Wasserman and Wicky (2003) highlighted the importance of recognizing the present avalanche scenario in choosing the right risk mitigation strategy and Harvey (2008) introduced four distinct avalanche problems: New snow, old snow, wet snow and wind driven snow.

Back in North America, the preliminary concept developed by Atkins (2004) was used as the foundation for the Avalanche Danger Scale revision project, which developed the Conceptual Model of Avalanche Hazard (Figure 1) after extensive and exhaustive efforts by an international committee. Avalanche character was a key component of this model and a matrix was created (Table 1) that defined the key characteristics of various kinds of avalanche (Statham *et al.*, 2010).
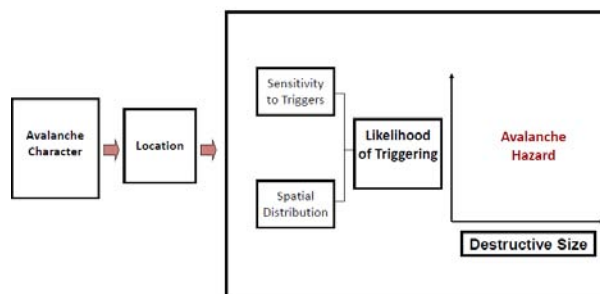


Figure 1: Conceptual Model of Avalanche Hazard (Statham *et al.*, 2010)

Soon after, avalanche character and the conceptual model were adopted by the Canadian Avalanche Centre (CAC) as fundamental components of the forecasting of avalanche hazard and communication of danger to the public. Avalanche character was added to the CAC's recreational Avalanche Skills Training (AST) course curriculum for the winter of 2010-11 and included in support-

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ing decision aids such as the Avaluator V2.0 (Haegeli, 2010) and the Decision Making in Avalanche Terrain Fieldbook (Haegeli, Atkins & Klassen, 2010a).

Avalanche character has also been adopted by numerous other agencies including Parks Canada and Kananaskis Country in Canada as well as the Utah Avalanche Centre (UAC) and the Colorado Avalanche Information Centre (CAIC) in the United States, and it has become a central component of avalanche danger communication in North America.

## 2. DEFINITIONS

The Danger Scale project's avalanche character matrix (Statham *et al.*,2010; Table 1), divides avalanches into eight categories:

- Loose Dry
- Loose Wet
- Wind Slabs
- Storm Slabs
- Wet Slabs
- Persistent Slabs
- Deep Persistent Slabs
- Cornices

Each category is defined according to weak layer or failure interface, slab properties, persistence, weak layer location, propagation potential and relative size potential.

The CAC expanded on the matrix by developing a series of "Avalanche Problem Essentials" papers (Haegeli, Atkins & Klassen, 2010b) aimed at recreationists. These papers describe the development, associated avalanche activity pattern, tips on recognition and assessment in the field and risk management strategies for each of the eight avalanche character types. These expanded descriptions provide the basis for teaching users about avalanche character and its role in decision making, thus assisting users of CAC forecasts in making informed decisions about hazard and risk mitigation.

Table 1: Avalanche Character Matrix (Statham *et al.*, 2010)

| Character | Weak Layer/ Interface | Slab Properties | Persistence | Weak Layer Location | Propagation Potential | Relative Size Potential |
|---|---|---|---|---|---|---|
| Loose Dry | Various (no cohesion) | None | Hours/days | Near the surface | Down slope entrainment | R1-2 |
| Loose Wet | Various (no cohesion) | None | Hours/days | Any level | Significant down slope entrainment | R1-3 |
| Wind Slabs | DF, PP | 4F-K Wind transp. | Hours/days | Upper pack | Terrain feature | R1-3 |
| Storm Slabs | PP, DF | F-P Soft-stiff | Hours/days | In or just below storm snow | Path | R1-4 |
| Wet Slabs | Various | 4F-P Wet grains | Hours/days | Mid pack ot deep | Path | R1-5 (climax) |
| Persistent Slabs | PWLs such as SH, FC, CR, FC/CR combo | 4F-P Stiff-hard | Weeks/months | Upper to mid pack | Path to adjacent paths | R2-4 |
| Deep Persistent Slabs | PWLs such as SH, FC, CR, FC/CR combo | 1F-K Hard | Weeks/months | Deep or basal | Path to adjacent paths | R1-5 (climax) |
| Cornices | ~ | ~ | Months w/ short peaks | ~ | ~ | ~ |
| Comment | Typical failure plane | Typical kind of slab | Typical duration of instability | Relative to HS | Typical expectation | Typical range of size relative to path |
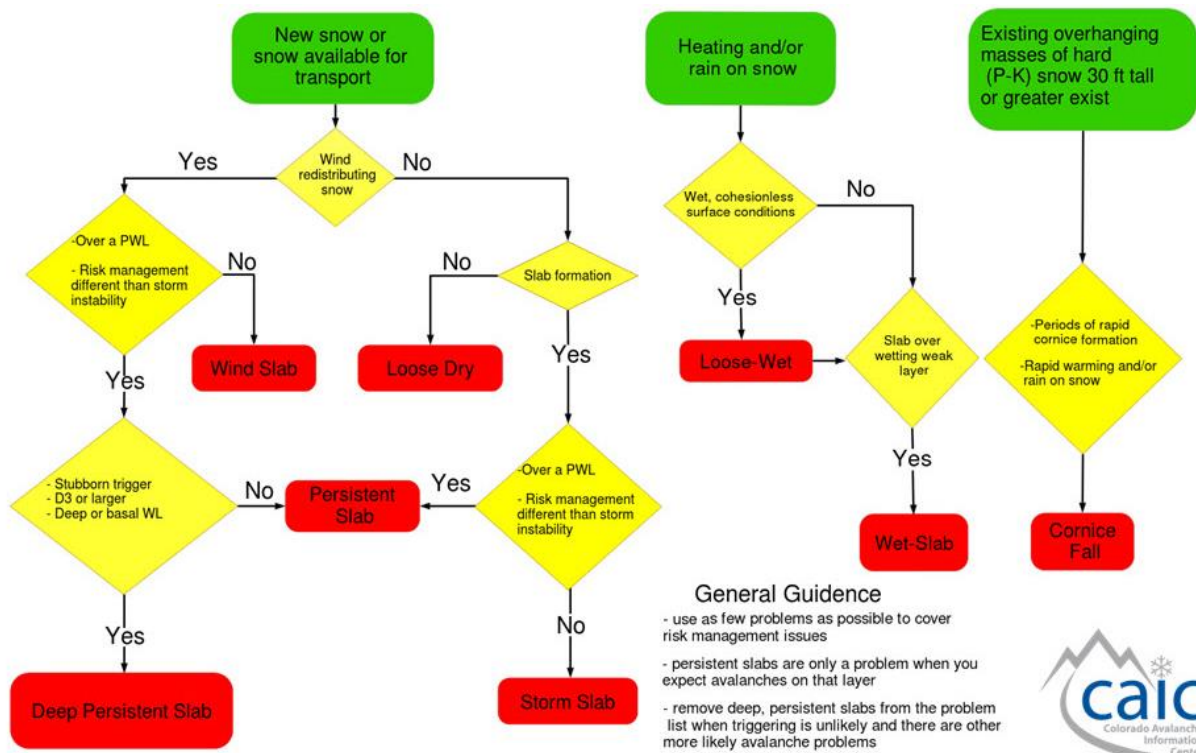
Figure 2: Avalanche Problem Guidance for Backcountry Forecasters (Greene & Lazar, 2012)

The matrix and the CAC's expanded definitions also provide internal guidance to forecasters who must assess which avalanche character should be used to describe the current problem(s) in a given forecast.

Other jurisdictions have used the original matrix and the CAC's work to develop internal and external guidance statements. Notably, the CAIC has developed a quick reference flow chart for their avalanche forecasters (Figure 2; Greene & Lazar, 2012).

## 3. AVALANCHE CHARACTER IN PUBLIC SAFETY INFORMATION IN CANADA

In recent years, the public avalanche forecasts in Canada have become increasingly "chunked," meaning information is broken down into shorter, simpler statements that incorporate graphical elements to provide to-the-point information in a standardized format. Avalanche character fits squarely into the "Avalanche Problem" chunk of information (Figure 3), which describes:

- What kind of avalanche is expected.
- Where the problem exists.
- The likelihood of triggering.
- How large an avalanche is expected.

- A brief information statement.
- Travel and terrain advice, which describes travel techniques and terrain choices that help mitigate risk.

Chunking the Avalanche Problem and using avalanche character as part of the description of the problem significantly enhances avalanche forecasts by making it simple for the user to understand not only what the regional danger rating is but what kind of terrain choices and techniques might be employed to manage risk.

Much like professionals, who adjust their terrain and risk mitigation techniques according to avalanche character regardless of other factors such as snow stability ratings (Atkins, 2004), recreationists also need to take the character of the existing avalanche problem into account when making terrain choices under a given danger rating.

For example: a Considerable danger rating could be applied when many small Wind Slabs are expected to run only to terrain transitions. At the same time, a Considerable danger rating could also be applied when infrequent but large, Deep Persistent Slabs will likely to run to valley bottom.

In these two scenarios however, even though the danger rating is the same, completely different terrain choices and travel techniques will be
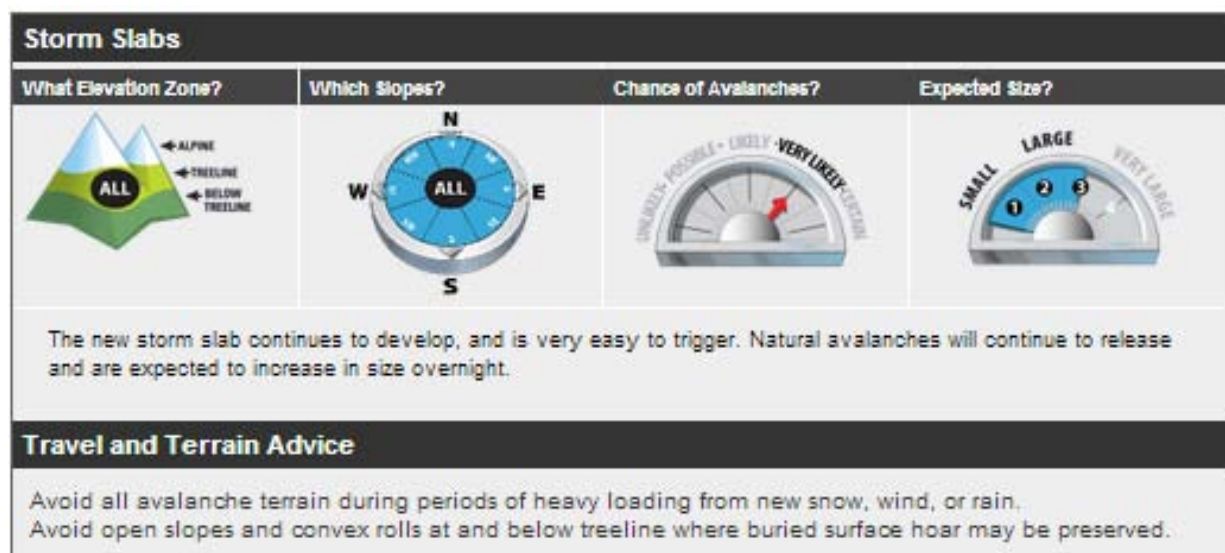
**Storm Slabs**

| What Elevation Zone? | Which Slopes? | Chance of Avalanches? | Expected Size? |
|---|---|---|---|

The new storm slab continues to develop, and is very easy to trigger. Natural avalanches will continue to release and are expected to increase in size overnight.

**Travel and Terrain Advice**

Avoid all avalanche terrain during periods of heavy loading from new snow, wind, or rain.
Avoid open slopes and convex rolls at and below treeline where buried surface hoar may be preserved.

Figure 3: CAC Avalanche problem information chunk, created using the AvalX forecasting software (Statham *et al.*, 2012)

required to manage risk. However, despite these efforts, our experience shows that the concept of adjusting terrain choices or travel techniques according to avalanche character is currently not well understood or practiced in the recreational community

## 4.   CHALLENGES AND SUGGESTIONS

Based on our experience, we have identified a number of challenges for the application of the concept of avalanche character in public avalanche hazard communication with proposed suggestions for addressing these challenges.

### 4.1 Terminology

In Canada, the terms *"primary avalanche concern," "avalanche problem," "avalanche character,"* and *"avalanche type"* are common. In other parts of the world *"avalanche threat"* and *"avalanche situation"* are common (Jamieson *et al.*, 2010). These terms are often used interchangeably, which creates confusion.

At the CAC, *primary avalanche* concern has been abandoned in favour of *avalanche problem*, which has evolved into the term that encompasses a variety of factors that together form a chunk of information in an avalanche forecast. Avalanche character is the part of the avalanche problem that identifies the kind of avalanche expected.

*Avalanche type* is actually a better term than avalanche character. However, avalanche type is already used in the Observation Guidelines

and Recording Standards (OGRS) of the Canadian Avalanche Association (CAA, 2007) to differentiate between slab and loose avalanches. We believe that avalanche character is simply an extension of the existing avalanche type definition and that the two concepts should be combined in the next revision of ORGS, at which point the term avalanche type should replace avalanche character as the term of choice.

We propose using the term "Avalanche Type" as the label for avalanche character, and that avalanche type definitions in the OGRS (CAA, 2007) be expanded to include the eight definitions currently in the avalanche character matrix.

### 4.2 Deep persistent slabs

Deep Persistent Slab is intended to mean the weak layer of concern is deep in relation to the snowpack as a whole. The avalanche character matrix describes the weak layer location as "deep or basal" which includes scenarios like basal depth hoar layers in a shallow continental snowpack or persistent weak layers several metres deep but still well above ground level in maritime or transitional snowpacks. This has led to confusion when forecasters (and users) from continental snowpack areas compare their problem to that in a deep intermountain or maritime snowpack.

We believe that a better distinction between persistent and deep persistent slab categories would considerably improve the application of the avalanche character concept.

## 4.3 Deciding on the most appropriate classification: persistent slab or not; storm slab or wind slab?

There has been much discussion about how to decide which category applies when storm snow or windblown snow overlies grain types that are commonly attributed to persistent avalanches. For example, if a wind slab is deposited on surface facets, is it a wind slab or a persistent slab? Similarly, a classification question arises when a storm slab lies on surface hoar grains. Furthermore, if a wind slab or a storm slab classification is applied in the above situations, can the classification be changed to a persistent slab later and if so, at what time?

At the CAC, in the scenarios described above, we tend to use wind slab or storm slab designations at the outset of a new problem, even when potentially persistent grains are likely to play a role in avalanche release. Generally, we hold off on using persistent slab until after initial loading has produced a notable avalanche cycle and it is clear further avalanches can be expected after the normal duration of a wind or storm slab cycle has expired.

A similar situation exists for the distinction between wind slabs and storm slabs. Clearly, most storms have wind associated with them and this plays a role in the development of slab avalanches during storms. However, at the CAC we tend to use storm slab during most major storms when avalanches can be expected on most aspects. After a storm ends, the forecaster must determine if any lingering avalanche activity is more likely on most aspects (in which case a storm slab designation is appropriate) or if activity will be more isolated to lee or cross-loaded aspects and features, in which case wind slab is more accurate.

In some wind/storm slab vs. persistent slab scenarios, it may be obvious that a problem will almost certainly become a persistent slab sooner rather than later. In a storm vs. wind slab situation, when avalanche problems develop in the absence of significant new snow loading and redistribution by wind is the primary factor creating slabs, wind slab is clearly the right choice. Certainly there are times where it's appropriate to apply persistent slab rather than wind/storm slab from the outset of a new problem or using wind slab during a storm.

If forecasters are debating which term best applies, it's important to remember that Atkins (2004) primary motivation for introducing the avalanche character concept was its direct link

to risk mitigation practices. Therefore, the desirable travel advice and the character of the likely triggering mechanism can help forecasters classify an avalanche problem when other criteria are ambiguous.

Probably more important than having hard and fast rules about when to use which designation is to ensure forecasters be consistent. Familiarity with the matrix and the detailed descriptions such as the CAC's Avalanche Essentials series is essential. Tools such as the CAIC's flow chart (Figure 2) are helpful. Perhaps the most important means of achieving consistency is peer discussion, both within the forecasting team and between partner agencies who are dealing with the same problem(s).

> In situations when it is difficult to decide between different avalanche character types, we propose the final classification should be based on the risk mitigation strategy that is more appropriate for the current situation. Consistency in these assessment situations among avalanche forecasters and agencies is paramount for providing a clear message to the users of avalanche bulletins.

## 4.4 Icons versus text

The UAC has developed a set of icons that depict avalanche character. Other icons may exist. In the initial phase of adopting avalanche character, the CAC obtained permission and used the UAC icons. When Parks Canada developed the AvalX forecasting system (Statham *et al.*, 2012), risk communications experts advised that not all information benefits from the application of graphics and recommended not to use icons to depict avalanche character because the concept was too complex to illustrate in a small thumbnail graphic in which many different types of avalanches look similar. As a result Canadian public avalanche forecasting operations that use AvalX do not use icons, relying instead on the established names.

> To help with standardization to some extent, it would be a good idea of those agencies that use icons also use text to describe the avalanche character.

## 4.5 Public understanding:

Professional guides intuitively understand the effect of different avalanche characteristics on decision making and risk management. However, using avalanche character as a primary

component in the formal communication of avalanche hazard in public safety products is a relatively new concept. Based on our anecdotal experience, we believe there is a considerable lack of understanding of the concept of avalanche character among public recreationists. While recreationists appear to understand there are different kinds of avalanches, they do not seem to fully grasp how avalanche character relates to a problem as a whole and the danger rating in particular, and—more importantly—how to use this information to make a better, more informed decision about managing risk.

Avalanche character is also new to recreational avalanche course curriculum. The adoption of products, such as the Decision Making in Avalanche Terrain Fieldbook, (Haegeli, Atkins & Klassen, 2010a) that support teaching avalanche character and its role in decision making has been slow. This suggests some avalanche course providers in Canada are likely not fully conversant on the subject and less than fully familiar with the link between avalanche character and decision making.

Public forecasting agencies using avalanche character to describe avalanche problems need to ensure they provide the background information users need to understand what avalanche character means and how it applies to the hazard assessment and risk management process. This can be done by way of hyperlinking on websites, providing access to reference documents, using consistent terminology in forecasts and other communications, writing informative articles and blogs, etc. See the CAC's Avalanche Problem Essentials series (Haegeli, Atkins & Klassen, 2010b) at avalanche.ca/cac/pre-trip-planning/decisionmaking as an example.

It's also very important that recreational avalanche course providers be familiar with and include in their courses the concepts of avalanche character, its role in the avalanche problem, and its link to decision making so students can effectively utilize this information in their risk management strategies.

> In addition to using the concept of avalanche character in avalanche bulletins, more effort should be put into clearly explaining the background and the benefits of the concept to recreationists and recreational avalanche course instructors.

## 5. SUMMARY

Including avalanche character in public avalanche safety products adds value and enhances decision making support and risk management for users. However, it is a new approach for communicating avalanche hazard that continues to evolve as more agencies adopt it and more thought is put into its role and application. This means all who use it or who plan to implement it should collaborate and cooperate to ensure common practice and industry standards are developed. Most important, it's essential that recreational avalanche course instructors become conversant in the topic so users are well educated and can effectively utilize this information to improve decision making and better mitigate risk.

Agencies planning to adopt avalanche character should carefully consider how to implement this change. There are a number of factors to take into account, some of the most significant ones being:

- Consider consulting with those agencies that have expended time and energy establishing the concept, standardizing terminology and definitions, and developing various tools to implement and teach avalanche character.

- If you plan to use icons to depict avalanche character, consider contacting the UAC and asking for permission to use theirs. This will help standardize iconography.

- Work with your forecasters to ensure they are trained and knowledgeable before they are expected to incorporate avalanche character into their forecasts.

- Be prepared to provide users with the information they need to effectively use avalanche character when you incorporate it into your products.

- Ensure you familiarize educators with the concept so avalanche character is incorporated into the curriculum of recreational avalanche courses.

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