WHY OBSERVERS' MAY NOT AGREE ON THE DESTRUCTIVE POTENTIAL SIZE RATING AND A DRAFT SCALE FOR MORE CONSISTENT RATINGS

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ABSTRACT: When looking at the same avalanche, observers sometimes rate the size differently on the Destructive scale. Different ratings for similar avalanches are more common for observers from different operations. We identify common reasons for the different ratings and propose guidelines for interpreting the D-scale. If the guidelines are adopted by operations and – ideally - by national and international avalanche associations (with changes following feedback from draft scale users), more consistent ratings and improved communication of destructive potential can be achieved.

KEYWORDS: Avalanche size, destructive potential, damage potential, avalanche classification

1. INTRODUCTION

Over the past year a group of us started discussing how different scenarios affect the use of the current Destructive scale (D-scale) when it comes to estimating avalanche size. The discussion began at the Elk Valley Snow Avalanche Workshop (EVSAW) in Fernie, British Columbia picked up some momentum at the 2023 Canadian Avalanche Association (CAA) Spring Conference and has now brought this discussion to the International Snow Sciences Workshop in Bend.

It has been over 40 years since the introduction of the Canadian Avalanche Size classification scale (McClung and Schaerer 1981). Since then, risk-based decision-making has been introduced, the range of skill sets for observers has increased, additional technology is available to observers, and an increased volume of observations is being made. These changes, coupled with the discussions over the past year, have identified a desire to improve accuracy and consistency when using the Destructive Potential size scale and possibly create an international standard for avalanche size.

Initially, a discussion was ignited by a presentation titled 'A More Visual Method for Estimating Avalanche Size' (EVSAW, Fernie, BC, Nov. 2022). This presentation introduced the concept of including terrain traps in size estimation, which divided the audience. A second presentation followed, titled 'When Rating Avalanche Size, Should We Consider Terrain Traps and Escape Skill?' (Canadian Avalanche Association Spring Conference, Penticton, BC, May 2023) Subsequently, an open discussion group exchanged ideas, which led to the development of a survey where 39 avalanche professionals responded with their insights. Reviewing the survey responses, we identified two instances where size discrepancies appeared.

Interpretation Differences: Reporting observers appear to interpret the criteria for each rating differently. This could be due to variations in training, experience, or local conditions that influence their perception of avalanche size.

Operational/Objective Differences: Observers from different operations and locations appear to often have specific operational and personal contexts that impact their ratings. Factors include the type of terrain; snowpack characteristics; mobility and skill of potential human involvements; and the forecast consequences of an avalanche on elements at risk. There can be considerable variation between observers as their context and biases change.

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2. OBJECTIVE

The primary objective is to enhance the consistency of size estimation across different observers, irrespective of their experience, educational background, geographic location, or operational circumstances. This can be achieved through the refinement and implementation of comprehensive guidelines that provide clear instructions and strategies for accurate and consistent size estimation.

If the guidelines are adopted by operations and – ideally - by national and international avalanche associations (with changes driven from practitioner feedback), more consistent ratings and improved communication of damage/destructive potential can be achieved.

3. APPROACH

The approach for this revamp was to identify the key biases and observational errors that create a situation where observers of all levels (seasoned practitioners, recreationists, etc.) assign a different size to the same avalanche. We also tried to identify key points within the scale where we saw the greatest likelihood of bias affecting the scale. This was done through presentations followed by open discussion with a variety of practitioners from various sectors of the industry. There was also an open discussion with keen members of the public through a user survey.

We also reviewed avalanche size classifications including AAA (2022), AAA and NAC (2023), CAA (2016), EAWS (2023), Perla (1980) and New Zealand Mountain Safety Council (2017).

4. FINDINGS

Historically, if an avalanche could bury, injure or kill someone it was considered a size D2. This has led to small avalanches in specific cases being called a size D2. Through the early part of the 1980s, several seasoned practitioners mentioned that they would only use the destructive descriptors to gauge size. Mass and run length were not utilized. At some point, through the 1990s and with the change to risk-based decision making and the advent of technology that increased the ability to make more accurate observations, the use of Mass and Run Length has become more common.

The other factor that likely influences the way the size scale is interpreted is when the mobility, skill and vulnerability of users affects their judgment. A more or less vulnerable person may feel differently about how big an avalanche actually is. A person's mode of transportation can impact their perception of avalanche size. Someone on foot might feel more vulnerable and view an avalanche as larger since they lack the speed to escape it, whereas a strong rider on skis or a snowmobile might feel more equipped to maneuver and avoid danger.

Perspective can also affect size estimation. An example given during our CAA AGM presentation was when you observe an avalanche from a helicopter, we often find ourselves underestimating and when we ski cut the same size avalanche we may overestimate.

When observing an avalanche from a helicopter, the vastness of the surrounding landscape and the distance from the avalanche path can make the avalanche appear smaller than it is. The helicopter provides a broader perspective that might diminish the apparent size of the avalanche in relation to the larger terrain.

On the other hand, when you're directly involved and triggering an avalanche by ski cutting, you are in close proximity to the event. This close-up perspective can make the avalanche seem larger and more immediate, potentially leading to an overestimation of its size.

Figure 1: Viewed from the deposit, this avalanche (same as in Figure 2) might be rated as size D2. Ben Bradford Fernie Alpine Resort photo.

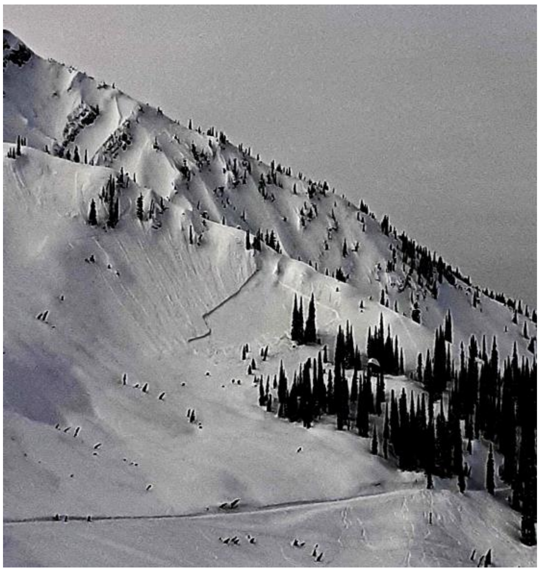

Figure 2: Viewed from a helicopter, this avalanche (same as in Figure 1) might be rated as size D1. Tyler Carson Fernie Alpine Resort photo.

Many survey respondents commented that they were likely to - or have in the past - misjudged size due to emotional stressors, work dynamics and operational demands. Anecdotally, underestimation may be more common than most observers realize, and have consequences for the end user.

High stress situations can affect cognitive processing and decision-making. When facing an intense or unexpected event like an avalanche, individuals may experience heightened emotions such as fear, anxiety, or panic. These emotions can alter perception and lead to an overestimation or underestimation of size, as well as influence their overall risk assessment.

Avalanche workers and avid recreationists may develop biases based on their experiences and familiarity with certain conditions. This could lead to a tendency to underestimate or overestimate avalanche size based on their previous encounters. For instance, if an observer frequently deals with smaller avalanches, they might unconsciously downplay the size of a larger event, or vice-versa.

Personal beliefs, experiences, and individual attitudes can all contribute to biases. These biases might influence an observer's judgment of the severity or potential consequences of an avalanche event. Personal biases can be related to factors such as past experiences, cultural background, or even peer or operational pressure. Wording within the Destructive Potential descriptors affects how people communicate their observations, whether consciously or unconsciously. The above-mentioned factors can affect size determination if the descriptors are not clearly defined, inclusive of all the descriptors employed.

Destructive potential is a hard concept to grasp. Measured scales and observations were reported in the survey and in conversations as being easier to understand than ones based on empirical evidence. Recreationists and many practitioners have difficulty estimating destructive potential because they have little or no direct experience with people killed, cars damaged, or a railway car destroyed by an avalanche in motion. Static indicators were reported as easier to estimate as well as quantify, thus providing a more reliable resolution in disagreements.

Static indicators for dynamic events are challenging at best. We must accept the fact that there will be some differences between practitioners and that’s OK. Volume-based estimations are a reasonable expectation for recreationists and could be extremely helpful for practitioners with limited observations of D2 and larger avalanches in motion. Mass for avalanche workers seems to be the standard when there is disagreement - it is seen as the common choice when looking for a resolution.

5. RECOMMENDATIONS

We think with some small adjustments in layout and wording, as well as some guidance on the use of the scale to help manage bias, we can make considerable gains in consistency between observers and help mitigate some of the above-mentioned effects.

We believe that the Destructive descriptors add considerable benefit when it comes to estimating size. As an example of a way of clarifying descriptors, we could create a bank of definitions including parts of the Destructive Descriptors like "Relatively harmless," which refers to something that poses little or no significant threat or danger in comparison to other more severe or dangerous alternatives. It implies a low level of potential harm, risk, or negative impact on individuals, the environment or society. Despite being not entirely without consequences, the effects of a relatively harmless entity are generally mild, manageable, or easily rectified.

Overall, the term "relatively harmless" underscores the importance of context and perspective, acknowledging that while something may not be entirely benign, it still poses a much lower degree of harm than other more serious alternatives.

On the other end of the scale the superlative “Largest snow avalanche known” has a different challenge in that it causes observers to underutilize it as an option due to their belief that although they may have witnessed a size 5 avalanche, it probably doesn’t qualify as being in the realm of the “Largest snow avalanche known”. We feel this wording brings little value and unknowingly adds an element of peer pressure when sizing an observation, and should therefore be removed.

The addition of volume descriptors may also help visualizations when estimating avalanche size. This will specifically help user groups with lower levels of experience observing avalanches in motion. It can provide valuable information about the size and magnitude of the avalanche, even if the avalanche in motion was not witnessed.

The largest challenge here is finding volume descriptors that are universal. Not everyone knows how big a city block is, football fields vary in size depending on the country it is being played in and whether you're speaking to North American Football or Soccer. Using specific measures like hectares can also be challenging. We chose volume descriptors that we hope are ubiquitous in all areas affected by Avalanches. The draft scale below includes volume descriptors from the US Avalanche Encyclopedia (avalanche.org/avalanche-encyclopedia), which is based on discussion between four practitioners from Spain, the USA and Canada.

Table 1: A draft scale for more consistent rating of damage potential.

Size and Data Code	Damage Potential	Typical Mass	Typical Deposit Volume	Typical length	Typical Impact Pressure
D1	Relatively harmless to a person on foot. Unlikely to bury a person, except in run out zones with unfavourable terrain features (e.g. terrain traps)	< 10 t	Avg. apartment. ≤ 1 m	< 10 m or City Bus	1 kPa
D2	Could bury or kill a person on foot.	10^2 t	Floor of a large house ~2 m deep	100 m or a Soccer field	10 kPa
D3	Could bury and destroy a car, damage a truck, destroy a wood-frame house, or break a few trees.	10^3 t	Hockey rink 2-3 m deep	1 km	100 kPa
D4	Could destroy a railway car, large truck, several buildings, or a forest area of approximately 4 hectares.	10^4 t	4 Hockey rinks 4 m deep	2 km	500 kPa
D5	Could destroy a village or a forest area of approximately 40 hectares.	≥ 10^5 t	5+ Soccer fields 8 m deep	3 km	1,000 kPa

Notes:

To assign a size, observers should use all the factors (columns) that they can confidently estimate.

Size 1 is the smallest size description but half sizes may be used by experienced observers for avalanches which are midway between defined avalanche size classes.

Typical impact pressures for each size number were given by McClung and Schaerer (1981).

The number “0” may be used to indicate no release of an avalanche following the application of control measures.

The playing area of two tennis courts is comparable to the area of a hockey rink.

The addition of annotated static deposit and crown images with the terrain and/or objects within the image to help with context and size estimation would help. Currently, the EAWS glossary and the US avalanche encyclopedia use and include photos to aid in this. We believe this would be helpful for observers who have less experience observing avalanches.

We have created an example of how we believe with some minor changes we could improve consistency between observers. The guideline (Table 1) is our first attempt, and we will be reaching out for feedback post ISSW 2023. The guideline is based on survey feedback and previous renditions of the guideline.

5.1 Definitions

Damage potential - The damage potential of an avalanche is a function of its mass, flow density, speed and length on a typical slope.

Could - implies maximum damage potential

Relatively harmless - poses little or no significant threat or danger compared to other more severe alternatives (Size D2, D3, D4, D5) on open planar slopes.

5.2 Potential Damage scale images for reference

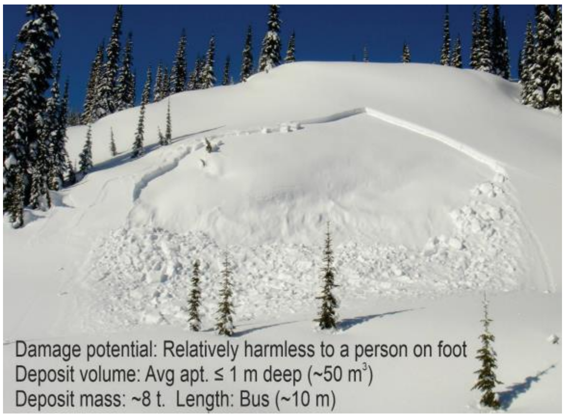

Figure 3: Example of annotated D1 avalanche. ASARC photo.

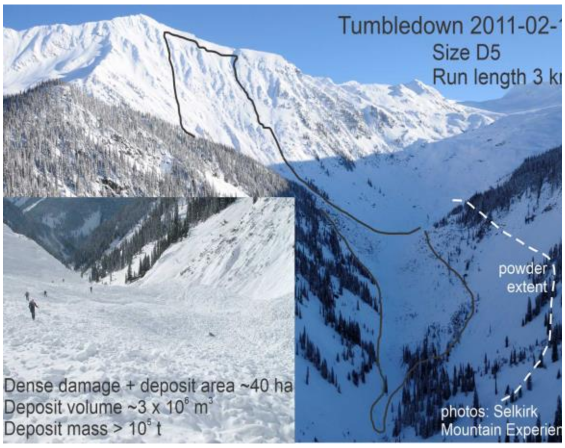

Figure 4: Example of an annotated D5 avalanche. Selkirk Mountain Experience photos.

6. SUMMARY

We will need to follow up with some anecdotal and data-driven support for this once put in place. Our key components to improve consistency between observers are as follows.

Updated Standardized Guidelines: Improve and update standardized guidelines that clearly outline the step-by-step process of size estimation. These guidelines should cover various types of avalanches that require size estimation and provide detailed guidance on how to approach each situation. It must also have clear definitions of terms related to avalanche size as well as guidance on how observers should use factors (columns) that they can estimate with confidence.

Visual References: Incorporate visual references, such as images, which illustrate different sizes and dimensions. Visual aids can significantly enhance understanding and reduce ambiguity, leading to more consistent size estimations.

Comparative Scales: Introduce and improve comparative scales or reference objects that observers can use as a basis for estimation. For instance, using common visual references, distance scales, estimable depths, average estimated damage, or recognizable landmarks as references can help observers gauge sizes accurately.

By focusing on these key components, the objective of improving consistency in size estimation among observers of varying backgrounds and experience may be effectively addressed. Regular monitoring, adaptation and a commitment to refining the guidelines will contribute to the long-term success of this initiative.

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