An avalanche triggered with explosives at Loveland Ski Area in Colorado. The crown face was 60 to 120 cm deep and involved about 30% of the start zone. The conditions in the track were not especially conducive for a long runout. We would classify this avalanche as R2D2. *Photo by Dale Atkins*

ACCURATELY ASSESSING AVALANCHE SIZE:

The Ins and Outs of the R- and D-Scales

Story by Karl Birkeland and Ethan Greene

Assessing avalanche size can be like telling a fish story. To one person the fish is the monster of the deep that almost dragged the boat over, while to another person that same fish was a minnow. However, with avalanches an accurate and unbiased assessment is critically important to improve communication between avalanche workers and also to maintain consistency in our databases. Although most observers do a great job of assessing avalanche size, we have noticed an unfortunate increase in the incorrect use of avalanche size, especially the relative (or R-) scale. Descriptions of the size scales are included in SWAG *(Greene et al., 2010)*, but we are writing this short article to try to help clarify the use of each of the size scales, and to discuss how they complement each other.

The R-Scale

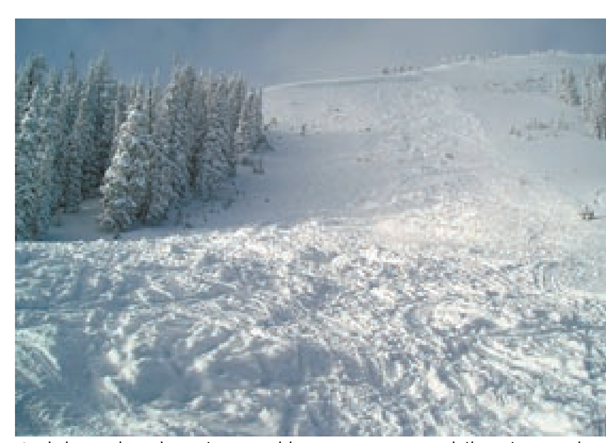
The R-scale, or relative-size scale, has served as the standard size classification in the United States since at least the start of the Westwide Avalanche Network data in 1968. At its core, the scale is a simple estimate of the size, based on volume, of an avalanche relative to the path in which it occurs. Sizes range from R1 (very small relative to path) to R5 (maximum or major, relative to path). When estimating the relative size of an avalanche, remember that you are trying to compare the current avalanche with the largest avalanche that path could produce. The size is not just the proportion of the start zone that released. The R size is a function of the depth and width of the slide, as well as the conditions in the track. For example, an R5 slide would run far past where you would normally expect. For paths ending below treeline, an R5 (major or maximum, relative to the path) avalanche would remove a significant amount of timber. Likewise, an R4 slide (large, relative to the path) would generally run full track and might also take out a few large trees. A slide where the whole start zone releases but the crown face is only a foot deep is unlikely to be an R4 or R5 slide unless the conditions in the track are such that a large volume of snow ends up at the end of the runout zone.

The D-Scale

The D-scale, or destructive-size scale, has been the standard size classification in Canada for many years. When the first version of SWAG was released in 2004 the working group decided that using both scales would be the most complete way to describe avalanche size, so the D-scale was added to US guidelines. The D-scale is an assessment of the destructive potential of an avalanche. Sizes range from D1 (relatively harmless to people) to D5 (could gouge the landscape, largest snow avalanche known). A D4 avalanche could destroy a railway car, large truck, several buildings, or a substantial amount of forest. The description of the potential damage produced by avalanches in each size category is a very useful tool for classifying an avalanche in the field. It also helps all of us select similar categories and thereby maintain consistency between operations and regions. With the D-scale, half sizes are sometimes reported. The scale also provides the typical mass (which increases exponentially) and typical path length for each D-size, though these can occasionally vary quite a bit from avalanche to avalanche.

Combining The Scales: Why Use Both?

Classifying avalanche size resulted in numerous discussions for the SWAG working group. In the end, we decided that using both scales gives operations flexibility and provides the most complete picture of avalanche activity. Note that both scales are qualitative assessments of avalanche size. As such, they are useful if you are communicating recent avalanche activity within or between operations or if you are looking back and assessing historical cycles. However, the utility of the scales is only as good as the consistency between observers, past and present. While we can use the categorical values of the scales in some statistical analyses, saying a specific avalanche was an R3D4 is closer to saying the water was warm than it was 16.8 ∞C. This is true for both scales since numbers associated with the categories are simply estimates meant to give each level some context.



A slab avalanche triggered by two snowmobilers in northern Colorado. The slide involved about 70% of the start zone, but stopped well inside the boundaries of the runout zone. We would classify the avalanche as an R3D2.5. *Photo by Spencer Logan*

Each scale has its advantages. The R-scale is especially useful for forecasting if the forecaster is not familiar with the particular avalanche path, and it can also give a hint of the current avalanche character *(Atkins, 2004)*. For example, a report of an R4 avalanche would tell a forecaster that avalanches are running deep, propagating far, or both. On the other hand, the advantage of the D-scale is that it tells us the destructive potential of a particular avalanche. This is critically important for engineering applications and it may be easier for avalanche workers to visualize the destructive potential of a particular avalanche rather than its size relative to the path.

Utilizing the strengths of both scales can be valuable for avalanche forecasting operations. Imagine you are forecasting for a mountain range. You know you have a buried layer of faceted grains and the next snow storm is rolling into your area from the north. An observer on the north end of the range reports three natural avalanches, and two of them are R4s. As the storm progresses through your mountain range, you know there is the potential for more avalanches to release that are large with respect to the path. If there are big paths in the central and southern portions of your mountain range, these are going to be dangerous

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and destructive avalanches. Like we say in all of our avalanche awareness classes, recent activity is the best predictor of further activity. Large avalanches in small paths are likely to be good predictors of large avalanches in large paths with similar snow conditions.

In contrast, hearing about a D4 avalanche makes all of us pay attention. However, a forecaster has to know the particulars of the path to extrapolate the D size to other areas. For example, a D3 avalanche could be a small avalanche involving only new snow in a large avalanche path, or it could be a large, deep slab avalanche in a small path. In short, neither scale gives the complete story by itself, so using both scales is advantageous. For US avalanche operations, keeping the R-scale is especially important because it provides consistency with other data collected for many years. However, the US was not the first to use both scales. The operation at Canada's Rogers Pass has been using an avalanche classification system that includes both an absolute and relative size for many years *(McMahon, pers. comm., 2009)*. They document avalanche size with a D scale size and a qualifier of Large, Medium, or Small, which describes the size of the avalanche with respect to the path. Thus, they might describe a specific avalanche as a "Small D3" or a "Large D2."

Conclusion

As a community, we need to do our best to accurately and consistently estimate avalanche size. Having a good understanding of the R- and D-scales can help us to do that. However, the most effective tool for improving size estimates is good mentoring from experienced avalanche workers. Those folks have likely seen a multitude of conditions and a wide variety of avalanche sizes in both relative and destructive terms, and that gives them the perspective to better assess the size of various avalanches. Accurate size assessments are important for communicating between and within various avalanche operations and for maintaining useful long-term avalanche databases.

An avalanche triggered with explosives in the Wasatch Mountains of Utah. The crown face encompassed almost all of the start zone, and the slide ran full track and destroyed a few large trees at the toe of the path. We would classify the avalanche as R4D4. *Photo by Craig Gordon*

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Karl Birkeland (left) is an avalanche scientist with the USDA Forest Service National Avalanche Center, and Ethan Greene (right) is the director of the Colorado Avalanche Information Center. Karl and Ethan first worked together during the 1990/91 season when Ethan, an undergraduate at Montana State University, helped Karl out as an intern during the first year of operation of the Gallatin National Forest Avalanche Center. That first year the GNFAC was a one-employee, two-intern operation run (no kidding!) out of the office supply closet at the forest. Photos by Kelly Elder.