**Inter-Party Avalanche Incidents: a model and a conversation**

By Charlie Hagedorn

Inter-party avalanche incidents: Do they happen? What can we learn about them?

First: Yes. Inter-party incidents happen. Since 2001, at least seven people have died in North American avalanches triggered by another party.

Second: A simple model for inter-party incidents suggests that the rate of inter-party incidents may grow like the density of parties squared and that the inter-party incident rate is proportional to avalanche size. As a rule-of-thumb, inter-party incidents have happened when there was more than one party per twenty avalanche-areas. See definitions below.

A possible inter-party incident in December 2015 drew me deep into this subject. As the number of people entering the winter backcountry of the Cascades continues to grow, I wondered how the rate of inter-party incidents might grow. That exploration led to a paper: *Inter-Party Avalanche Incidents May Increase Quadratically With Party Density*. The paper is written for you – this article is the movie-trailer to pique your interest in reading the real thing.

**A model:**

The paper constructs a simple model as a foundation for a conversation about inter-party incidents. The model has the simplest of beginnings – the assumption that the rate (*R*single-party) at which parties trigger avalanches is proportional to the number of parties (*N*parties) in an area *A*.

It is convenient (trust me) to switch to a notion of party densities, where :

An inter-party incident requires two events: First, a single party must trigger an avalanche and second, at least one other party must be unlucky enough to be within the avalanche, with area *A*avalanche . We’ve handled the first with *R*single-party. If we assume parties are uniformly-likely to be anywhere in our area, then the probability that at least one is struck by an avalanche is , so

For simplicity (the qualitative conclusions are the same), we’ll approximate as *N*parties and switch to densities again.

This is a key result. The model suggests that the rate of inter-party incidents grows like the square of the density of parties. If there are twice as many parties, there will be *four* times as many inter-party incidents. Furthermore, the inter-party avalanche incident rate should grow when the day’s avalanches are larger. These conclusions are not earth-shattering, but they help to make discussion of inter-party incidents more precise.

There is a second question we can ask, and it has an actionable answer: “For this model, at what party-density will inter-party incidents become a meaningful fraction of all incidents?”

First we need the overall incident rate:

Simple enough, right? Using our results from before, this can be suggestively-arranged as

This has a useful interpretation for forecasters, land-use planners, and backcountry travelers: The model suggests that when approaches one, a party is as likely to be involved in an inter-party incident as it is to trigger an own avalanche, as seen in Figure 1. Indeed, as we will see shortly, every inter-party avalanche incident examined in the paper had , and most were closer to 0.1 . Forecasters will note that this observation sidesteps the hard part of forecasting – determining . On a day when only D1 slides are likely, inter-party incidents are, in general, *much* less likely than on days with D2.5+ avalanches.

Figure 1: Illustrative plot showing quadratic growth in inter-party incidents surpassing linear growth in single-party incidents when . In this example, this occurs at parties/km2. The vertical axis in these plots is poorly determined, and varies greatly from day to day – the figure is included here as a guide to intuition.

Figure 2: Upper panel: Approximate fraction of inter-party avalanche incidents as a function of party-density, measured in units of avalanche-area. Lower panel: Approximate values of as discerned from inter-party avalanche incidents and near-misses.

**Discussion:**

With this model in hand, we can consider its implications for travel practices. In particular, it focuses our attention on party density and avalanche size.

Terrain, access, and timing tend to focus parties into small areas. In a narrow couloir, two parties alone can yield a density approaching urban. On a deep storm day, arduous trailbreaking means that parties can pile up into a paceline on a single skintrack – when those clumped parties begin to ski, they will be close to each other. In a large bowl, multiple snowmobile parties can choose to high-mark or rest in terrain with overlapping avalanche paths. On an optimal-conditions day in the big mountains, parties can queue up at constrictions on big routes – in April 2019, reportedly 16 people attempted to ski the Grand Teton on a single morning. On both small scales and large, we must not become too crowded, lest we begin to harm ourselves.

**Until we can control the weather, avalanche size is largely out of our control, but as avalanche size grows, we must be increasingly attentive to those above and below us.** When slides are sufficiently large, they can propagate to or from locations that are out of sight. At the same time, a larger slide is more-likely to find (or be triggered by) another party.

**Incidents:**

The paper examines in greater detail, with extensive references, thirteen events involving inter-party incidents and near-misses in North America. The fatal incidents are enumerated in the sidebar and those events amenable to quantitative study are shown in the Table.

It is interesting to look for commonalities among these incidents. As we can see from both the Table and Figure 2, the inter-party incidents occurred with , and most near 0.1, in qualitative agreement with the model’s prediction that values approaching 1 should be significant. Furthermore, after Krause’s suggestion to include avalanche character, it became clear that all but one of the incidents involved a slab avalanche. The reason isn’t known, but it is a clear signal in the small sample of incidents.

**Fatal Inter-Party Incidents: (sidebar)**

Lizard Range (2001): A party of skiers in poor visibility ski-cut the top of a drainage. The resulting slide ran out of sight around a corner; the party opted not to ski the route. The slide struck a party of thirteen. Two fatalities.

Empress Lake (2003): A snowmobiling party jumped a cornice onto a slope, disabling a machine mid-slope. A second party crossed above, triggering a slab. One fatality.

Boulder/Turbo Mountain (2010): A snowmobile festival of roughly two hundred people was struck by a D3 slide triggered by a high-marking participant. Forty were buried. Two fatalities.

Eagle Pass (2010): A party of snowmobilers triggered a D4 slide above a party of ten. One fatality.

Kendall Peak (2015 – possible): A solo skier disappeared on a stormy day, recovered six months later. Injuries were consistent with avalanche. Investigation found that two parties had triggered slides uphill of the burial location on the disappearance-day. The cause of the accident remains uncertain.

Temptation Path (2019): A party of snowboarders triggered a slab in constrained permanently-closed terrain adjoining a ski resort. The slide crossed a popular trail, and the party beacon-searched the debris. A beacon-less solo skier was discovered by probe-line the following day. One fatality.

**Mitigation:**

**Conclusion:**

If this subject has caught your interest, please check out the full paper. You can find it on the arXiv at XXXRC or at [www.kendallpeak.org](http://www.kendallpeak.org/).

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Charlie Hagedorn is a physicist and backcountry skier from Seattle, WA. He wants you think about parties above you and below you this winter.

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What do I want from the reader? I want them to read my paper. I want them to think about other people. I want them to know that the risk grows with avalanche size, and that the risk is quadratic in the party-density.