TRACKING HELI-SKI GUIDES TO UNDERSTAND DECISION MAKING IN AVALANCHE TERRAIN

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ABSTRACT

Heli-ski guiding can be considered a prime example of high stress, high consequence decision making in avalanche terrain. The combination of factors that make heli-skiing an exciting experience and high value industry create a high pressure scenario that demands consistently high quality decisions. Heli-ski operations provide a unique setting in which to examine the decision making of terrain usage of highly experienced professionals as they balance repurposed terrain, changing hazard ratings, group expertise and, a variety of other factors. Furthermore, given the recent fatalities in the heli-ski industry in Alaska, and the proposed new checks by the Alaska Occupational Safety and Health, there is also a strong desire to better understand, and quantify practices in this industry.

Previous work examining decision making in heli-ski operations has considered case studies of accidents, or close calls. However, no analysis has been undertaken to examine real-time, terrain focused, decision making outcomes as evidenced by ski tracks. Our work will present the first such results having GPS tracked and analyzed 18 days of heli-ski guiding at Majestic Heli-Ski in South Central Alaska. **Our results show that when repeatedly used terrain was examined, that there was a statistically significant difference in terrain usage under different avalanche hazard conditions**. This analysis highlights that the extreme values (i.e. the 90th, 95th and 100th percentiles) for slope angle, may provide more insight into terrain decisions than considering changes in the entire distribution for a given day due to the mobility of a heli-ski guide. **We propose that this methodology to perform real-time tracking and report the terrain based metrics, could be useful if operationalized in real-time for operational self-checking, transfer of institutional knowledge, and external auditing**. We compare these findings to decision making in self-powered back country settings which highlights that **decision making is about small scale thinking about the immediate landscape in both cases, but that heli-ski guides have more options to move into adjacent areas to aid mitigation.**

Figure 1: An example of typical land used by Majestic HeliSki (Photo: Hank de Vre)

AIMS

The focus of this paper is to examine heli-ski guide travel behavior in avalanche terrain given changes in:

- Avalanche hazard
- Avalanche problem
- Group demographics
- Number of days with the same group
- Lead guide

Our focus will be on how avalanche hazard is mitigated by use of alternative terrain within their permit area, and how the same (repurposed) terrain is used differently under varying avalanche conditions (Fig. 1).

METHODS

- Tracked lead guide for 18 days during normal operations.
- Documented avalanche forecast / avalanche problem / group ability / number of days / lead guide.
- Extracted terrain parameters in a GIS using 30m DEM.
- Used Kolmogorov-Smirnov two-sample test to test for statistically significant differences between days.

RESULTS

Considered terrain metrics for the whole day over the entire area (Fig. 2) and also for two different days in the same area (Fig. 3).

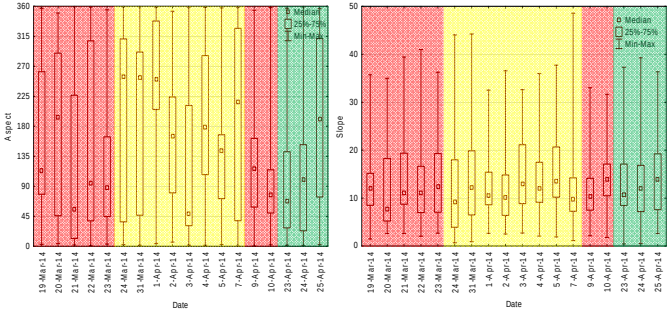

Figure 2: A box and whisker plot showing the minimum, maximum, median and interquartile range, for aspect in degrees from north (left) and slope angle (right) for the 18 days of the study. Color shading represents the avalanche forecast on the day, with red for considerable, yellow for moderate and green for low.

RESULTS

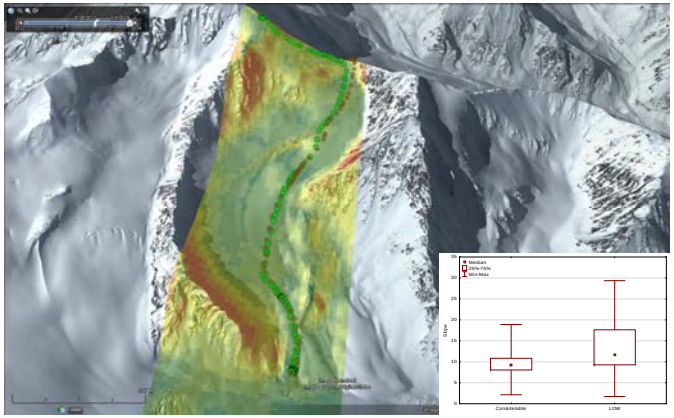

Figure 3: GPS tracks for April 9th shown with the orange diamonds (Considerable avalanche hazard / Wind slab and persistent slab) and April 23rd shown with the green circles (Low avalanche hazard / Wind slab and warming), overlain on a 30m slope map (where red is steep and green is lower angled), overlain on Google Earth. Inset graph shows a box and whisker plot showing the minimum, maximum, median and interquartile range, for slope angle. The Kolmogorov-Smirnov two-sample test showed that these were significantly different at the $p < 0.001$ level.

- When terrain metrics are grouped by avalanche hazard (low, moderate, considerable), or avalanche problem (persistent slab, warming), or lead guide (1, 2, 3), or number of days skiing (1-5) we do not observe any statistically meaningful difference between the slopes or aspects as indicated by the GPS tracks.
- When the same area is examined in detail, slope use on two days were statistically very different. On the low hazard day the groups skied markedly steeper terrain

CONCLUSIONS

Did not observe any difference between the slopes or aspects as indicated by the GPS tracks when daily data was grouped. We attributed this to both the simple terrain metrics, and also the **ability of a heli-ski guide to move to more favorable areas**, with better stability, and thereby maintain steeper, and often more sought after slope angles.

When individual tracks in repurposed terrain were examined, we noticed a **statistically significant difference in terrain usage under different avalanche hazard conditions**. This highlights that decision making is about small scale thinking about the immediate landscape, but that heli-ski guides have more options to move into adjacent areas to aid mitigation