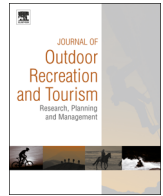




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Using GPS tracking to explore terrain preferences of heli-ski guides



Jordy Hendriks^{a,*}, Jerry Johnson^{a,b}, Christopher Shelly^c

^a Snow and Avalanche Laboratory, Montana State University, Bozeman, MT, United States

^b Political Science, Montana State University, Bozeman, MT, United States

^c Majestic Heli-Ski, Sutton, AK, United States

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ABSTRACT

Heli-ski guiding can be considered as a prime example of high-stress, high-consequence decision making in avalanche terrain. A combination of factors make heli-skiing an exciting consumer experience but also results in a high-pressure scenario that demands consistently high quality decisions by guides and operators to mitigate avalanche risk. A key mitigation tool used by heli-ski guides to avoid avalanches is careful selection of terrain to optimally meet client and safety demands. Therefore, heli-ski operations provide a unique setting to examine the terrain preferences of highly experienced professionals as they balance terrain, changing avalanche hazard, group expertise and, a variety of other factors.

Previous work examining heli-ski operations and avalanche hazard have considered case-studies of accidents, or close calls. However, no analysis has been undertaken to examine real-time, terrain-focused selection choices, as evidenced by the resulting ski tracks as taken by the guides. Our work is presented as an exploration, and presents the results of GPS tracks analyzed for 18 days of heli-ski guiding at Majestic Heli-Ski in Alaska. Given the limited size of our data set statistical robustness is limited.

Using handheld GPS devices we obtained a record of terrain used by lead guides under varying snow, avalanche and group conditions. The tracks are then analyzed within a GIS to extract key terrain metrics including slope, elevation and aspect. When these data are grouped by day, avalanche conditions, or group, there are limited differences in terrain attributes, which can be attributed to the simple terrain metrics used and also the ability of a heli-ski guide to move to more favorable areas under varying conditions to maintain desired slope angles. However, when we consider tracks in terrain which is re-used under different conditions, there is a statistically significant difference in terrain usage which is attributed to avalanche hazard conditions.

MANAGEMENT IMPLICATIONS

- The management implications of our work are that we present a tangible and practical method for the documentation and quantification of different heli-ski guides' terrain preferences under varying conditions.
- These methods provide a potential tool for the effective transfer of institutional knowledge from one guide to another within the operation.
- Furthermore, with careful consideration to key metrics used, this method also presents a potential opportunity for internal and, or external auditing by the operations themselves, or outside third parties (e.g. Alaska Occupational Safety and Health).
- Given the recent fatalities in the industry in Alaska, and proposed new checks by the Alaska Occupational Safety and Health agency, there is a strong desire to better understand, and quantify practices in this industry. One way to accomplish this is by observing terrain preferences by guides on a day to day basis.
- Finally, if our methods were applied in near-real time, they have the potential for real-time operational self-checking and management of terrain use by an operation on-the-fly, thereby aiding decision making with respect to terrain use, and maintaining institutional overview on all terrain decisions made.

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* Correspondence to: Snow and Avalanche Laboratory, Department of Earth Sciences, Montana State University, P.O. Box 173480, Bozeman, MT 59717-3480, United States.
E-mail address: Jordy.hendriks@montana.edu (J. Hendriks).

1. Introduction

Heli-skiing is the term used for skiing or snowboarding where slopes are accessed using a helicopter opposed to ski lifts. Since its inception in the 1960s, heli-skiing has become an increasingly popular activity with operators now established in most alpine countries around the world (Wanrooy and Anthony, 2006; Buckley, 2006; Hudson, 2012). Heli-skiing is a well-established industry with British Columbia, Canada having an estimated 90% of the global market share; in Canada the industry accounts for approximately 100,000 skier days with gross revenues exceeding \$100 million annually (HeliCat Canada, 2014). Outside of British Columbia, Alaska, USA now has the highest concentration of heli-ski companies (Heli-Ski US Association, 2015; Helicopter Skiing Directory, 2015). The industry continues to grow, and according to Hudson (2012), it is now one of the fastest growing sectors of the adventure tourism industry. There has also been an increase in the number of providers, with many newer operations starting in other locations around the world, including the Arctic (e.g. Greenland), Central Asia, and the Himalaya.

Heli-skiing is a unique mixture of the rapid transport afforded by helicopters and access to large expanses of remote alpine terrain. The industry offers a full range of experiences from moderate to extreme (Hudson, 2012). Virtually all operations adhere to generally accepted safety measures for backcountry skiing – with standard safety equipment like avalanche transceivers, probes and shovels, and increasingly, avalanche airbags. There is also attention given to avalanche transceivers briefings, avalanche rescue training, backcountry skiing protocols, and communications skills between guides and clients (Buckley, 2010). Alaska operations are often closely identified with the upper range of the extreme ski scene where many clients push for steep terrain; as a result, guides perform a balancing act between client safety and satisfaction as they compete for a relatively small number of such enthusiasts.

Client safety and accident avoidance are among the most important aspects of the product mix for the adventure tourism industry (Ritchie and Reid, 2013; Callander and Page, 2003; Cater, 2006). For winter recreationists in the mountain environment the primary hazard is avalanches (Schweizer and Jamieson, 2001; Voiculescu, 2009; McClung, 2014). Furthermore, given the known relationship between the more desirable skiing slopes (generally between 30° and 45°) coinciding with slope angles that pose the greatest avalanche risk (McClung, 2014), great care must be taken to balance safety with enjoyment. This is especially true for the helicopter accessed ski industry (i.e. heli-skiing) in alpine terrain (Gmoser, 1976). In Canada, between 1984 and 2005, 21% of all avalanche fatalities were during heli-skiing or snowcat-skiing (Boyd, Haegeli, Abu-Laban, Shuster & Butt, 2009). A key mitigation tool used by heli-ski guides to avoid avalanches is careful selection of terrain matched to meet client and safety demands. Given these considerations, heli-ski operations provide an exemplary setting in which to examine the terrain preferences of highly experienced professionals as they balance terrain, changing avalanche hazard ratings, group expertise and, a variety of other factors to safely and efficiently negotiate the given conditions.

Adventure tourism related accidents receive widespread attention from the mass and social media (e.g. Buckley, 2006; King and Beeton, 2006) and inevitably, regulators (O'Neil, 2011, 2013; Garcia, 2014). In Alaska, USA, the setting for this study, several high-profile accidents have catalyzed a discussion among operators to implement self-regulation of the heli-ski industry in an attempt to preempt regulation by state and federal safety agencies (O'Neil, 2011, 2013). Indeed, in response to a heli-skiing accident in 2013 near Haines, Alaska, two U.S. Senators requested a Federal investigation concerning improved safety conditions and standardized regulations for helicopter skiing in Alaska (Amdur, 2013).

The state of Alaska too, is involved in drafting additional regulations of the industry under the auspices of the Alaska Occupational Safety and Health Section of the Alaska Division of Labor Workforce and Development (Garcia, 2014). In many locations (i.e. European Alps, New Zealand, Canada) regulation of adventure tourism is recognized to help reduce accidents and present the regulated sectors as responsible corporate entities (e.g. Callander and Page, 2003; IFMGA, 2014; HeliCat Canada, 2014; Molloy, 2010; Cater, 2006).

In addition to industry and public sector institutional structures, safety in outdoor adventure tourism relies on an infrastructure that includes quality and well maintained equipment, a cadre of specialized safety staff (e.g. safety kayakers for raft support) and a well-trained guide staff. Among the traits aimed at minimizing risk to clients is reliance on expert judgment by guides (Buckley, 2010; Cater, 2006). For backcountry heli-skiing operations where traditional resort oriented safety measures may not be available (i.e. explosives) reliance on terrain awareness, decision making and judgment takes precedence. These mitigation techniques should be evident in the resulting terrain preferences under varying snow avalanche conditions. As many avalanche accidents are the result of flaws, or over-reliance on improperly applied decision shortcuts (heuristics), which can lead to inappropriate terrain selection (e.g. Atkins, 2010; McCammon, 2002, 2004; Logan and Atkins, 1996), it seems useful to begin to understand those terrain choices.

For backcountry skiers and riders the decision of whether or how to navigate potentially hazardous avalanche prone terrain is a mix of weather, snowpack conditions, group communication and limits of acceptable risk (McClung, 2014). While complex, these small group decisions are typically “self contained” in terms of responsibility and outcome. Fundamentally, the goal of the decision making process in avalanche terrain as a heli-ski guide is no different to that when making decisions in non-mechanized backcountry terrain; in all cases skier safety trumps other considerations (Grimsdottir and McClung, 2006). However, the process is somewhat more complex given the costs of transport and services, remote alpine terrain, client demands for more extreme terrain, weather and number of possible locations; in every respect, heli-ski guiding is set in an environment of high-pressure decision making, where safe and efficient decisions must be made on a daily basis (Gmoser, 1976; Grimsdottir and McClung, 2006). Furthermore, given the aforementioned recent fatalities in the heli-ski industry in Alaska, and the proposed new checks by the Alaska Occupational Safety and Health (AKOSH) (Garcia, 2014), there is also a strong desire to better understand, and quantify practices in this industry.

The focus of this paper is therefore to examine heli-ski guide travel behavior and resulting terrain use, primarily expressed by slope angle and aspect of terrain used, given changes in avalanche hazard, avalanche problem, weather conditions, group demographics, the number of days with the same group, and the lead guide. A lead guide is typically a qualified mountain or ski guide with advanced avalanche qualifications and experience, and is able to make slope scale terrain decisions with their guided group. Our focus will be on how avalanche hazard is mitigated by use of alternative terrain within their permit area, and how the same terrain is reused differently under varying avalanche conditions. We used GPS tracking of heli-ski guides to enable quantification of their terrain preferences under these varying conditions. Specifically, we will focus on the following four questions; (1) do we find evidence of the use of lower slope angles or different aspects, under higher avalanche hazard conditions or specific avalanche problems?; (2) do we observe variation in terrain use (i.e. slope and aspect) between different lead guides when working with similar groups under the same conditions?; (3) do guides who ski

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