Thesis project final report:

Piloting an Avalanche Advisory Program for Public Recreation in the Front Range and Eagle River Area Chugach Mountains: Strategy, Challenges, and Viability

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Piloting an Avalanche Advisory Program for Public Recreation in the Front Range and Eagle River Area Chugach Mountains: Strategy, Challenges, and Viability

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THESIS

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Abstract

This report covers a Master of Science in Outdoor and Environmental Education thesis project that piloted a grassroots, minimalist model avalanche advisory program for public recreation in the Front Range and Eagle River area Chugach Mountains: Alaska's most readily accessible avalanche terrain (managed by Chugach State Park). Despite heavy wintertime use and a history riddled with recreational casualties and fatalities, a program to provide organized information on snow and avalanche conditions, essential to improving awareness and safety, had yet to come to fruition for these mountains before this project. Through the experience of this project, what's involved in starting and developing a *backcountry avalanche advisory program* and in becoming an *Avalanche Specialist*, is explored. Six primary components of project methods are detailed: the extensive planning and preparation required for making this project a reality, identification of and outreach to potential stakeholders capable of helping sustain this project and provide for its continued development, working with students and volunteers, risk management, field work and avalanche advisory production, and partnerships that allowed for the project to eventually be made available to the public. This report also discusses project challenges, such as navigating Alaskan avalanche politics and land management implications for Alaska's avalanche terrain. It concludes with a section on the viability and sustainability of this project and the resultant advisory program that was made available to the public as the Anchorage Avalanche Center.

Overview

What's involved in starting and developing a *backcountry avalanche advisory program* and in becoming an *Avalanche Specialist*? This question frames an Alaska Pacific University (APU) Master of Science in Outdoor & Environmental Education (MSOEE) thesis project conducted in Anchorage, Alaska and the surrounding Chugach Mountains during the 2012-13 snow season. This project began, formally, in January 2012, but the idea was conceived years earlier.

The Anchorage Avalanche Center (AAC) is the most concrete result of this thesis project. Currently, the AAC is a grassroots and volunteer organization providing a backcountry avalanche advisory program for the Front Range and Eagle River area Chugach. During the 2012-13 snow season the program provided advisories for popular areas (see Appendix E, pg. 64) that included a *North American Public Avalanche Danger Scale* rating (see Appendix I, pg. 68), discussion of avalanche danger and concerns, danger trend, and travel advice. The program also consisted of creating a website that provides project information, weather resources, webcams, advisories, professional quality field observations, and a forum for hosting public field observations. The following report explores the development of the AAC from conception of this thesis project to the AAC going public, including a discussion on the viability and sustainability of the program for future seasons.

Additionally, this report explores the extensive preparation undertaken and other elements involved in making this project a reality: risk management, identifying stakeholders, stakeholder and community outreach, negotiating project-related politics, and gaining the experience and knowledge necessary for providing the best possible local avalanche information for enhancing recreational decision making. Studying weather, avalanche dynamics, and human decision-making in an abstract way was part of project preparation. Another part involved traveling extensively through the terrain under consideration by this project; learning experientially by studying the patterns, nooks, and crannies of the Front Range and Eagle River area Chugach.

An extensive review of the literature that informed this project explores mountain meteorology, important findings from the physical and social snow science research that informed effective project methods, key documents providing the closest thing to industry standards (guidelines) for undertaking such an effort, and prior work conducted towards this project's goal: developing a sustainable backcountry avalanche advisory program for public recreation in the Front Range and Eagle River area Chugach.

Literature Review

Introduction:

The literature review actually began many years ago with an introductory and best-selling text on avalanche basics: *Snow Sense,* by Alaskan snow science pioneers Fredston & Fesler (2011 – newest edition). This initial study was soon followed by formal training and more detailed texts, such as Level 1 and 2 backcountry avalanche hazard evaluation and rescue courses and the reading of Utah avalanche guru Tremper's (2008) classic: *Staying Alive in Avalanche Terrain*. Eventually, increasingly advanced training and learning opportunities (such as graduate level snow science courses and intensive workshops focused on meteorology and mountain weather forecasting) were sought and textual study supplemented with technical literature on avalanches and related phenomena, like *The Avalanche Handbook* (McClung & Schaerer, 2006), peer-reviewed snow science journal articles, *The Avalanche Review* (the trade and scientific journal of the American Avalanche Association), as well as core reading for anyone playing seriously in the mountains: *Mountaineering: The Freedom of Hills* (Eng, 2010).

The literature review, specific to this project, begins with a short section on becoming an Avalanche Specialist. This is followed by an overview of the meteorological and mountain weather forecasting study that was undertaken in preparation for this project. Avalanche-specific literature is then explored, which can be divided into four parts. The first two parts concern what can be considered the two dimensions of the snow science field: physical and social. There's a considerable amount of literature focusing on the physical science dimension. This literature is concerned primarily with avalanche formation, dynamics, and forecasting practice. There's also an appreciable amount of literature more characteristic of the social sciences. This literature focuses on what are commonly known as the human factors, concepts becoming increasingly recognized in the field of snow science as the popularity of activities involving recreation in backcountry avalanche terrain grows. While these two dimensions have been proposed to organize this literature review, it is actually quite difficult to separate most of the research literature into one category (physical or social) exclusive of the other.

The third part of the avalanche-specific literature review explores a preeminent and mandatory text for any snow-avalanche professional, referred to affectionately as *SWAG*. It also takes a look at the United States Forest Service (USFS) National Avalanche Center's (NAC) *business plan* and *operational guidelines* for backcountry avalanche programs. While in many regards vague, these two government documents are currently the best sources for understanding the operations, administration, and management of effective recreational avalanche advisory programs in the United States.

The final part of this literature review takes a brief look at prior work done towards the goal of this project: developing a sustainable recreational avalanche advisory program for the Front Range and Eagle River area Chugach. It focuses on a project conducted by APU Outdoor Studies graduate Jon Gellings in 2010: a feasibility study for a Chugach State Park avalanche information center.

Becoming an Avalanche Specialist:

Journal articles, government documents, and conversations with snow-avalanche professionals informed the notion of what's involved in becoming an Avalanche Specialist (the NAC documents' official title for what's more often referred to as an avalanche forecaster). Craig Gordon (2009) wrote an informative article on the path he took to get his job at the Utah Avalanche Center (UAC), one of the United States most esteemed avalanche centers. As another testament to the UAC's notoriety, Evelyn Lees (another UAC Avalanche Specialist) was profiled in an article (Green, 2006/2007) by the Bureau of Labor Statistics. Both articles point out that while there are no formal requirements for entering the occupation of Avalanche Specialist, there are trends as to the skills and qualifications of individuals holding these positions such as academic study or research relating to snow and avalanches and/or prior work experience in avalanche terrain in a decision-making role.

The NAC *business plan*, which will be discussed in more detail later, provides further insight into the typical qualifications of USFS Avalanche Specialists:

> Avalanche Specialists typically obtain training at the National Avalanche School, the International Snow Science Workshop, and on the job training at ski areas, avalanche centers and winter ski and mountaineering concessions. Avalanche Specialists may also have applicable degrees from universities and colleges. Currently, there are no clear guidelines for becoming an Avalanche Specialist; rather it is a combination of on the job training, master-apprentice training, and academic training. Avalanche Specialists are involved in avalanche education at the national and local level, stay abreast of current avalanche studies and may be involved in avalanche research. Avalanche Specialists keep in touch with the FS NAC and the other regional avalanche centers to assure consistency and high quality in the avalanche advisories/bulletins being provided to the public by the USFS. (USDA, 2001)

There seems to be two easily identifiable tracks for entering the field. The first, likely the most common, is through prior experience ski-patrolling in a snow-safety capacity. An understanding of why this is such a common pathway into the Avalanche Specialist occupation was enhanced, in part, through an extensive conversation with Simon Trautman (personal communication, September 25, 2013), director of the Sawtooth Avalanche Center in Ketchum, Idaho (a longstanding and reputable Type 2 USFS avalanche center). Mr Trautman explained that as a ski patroller working avalanche control routes exposure to avalanches is regular, which allows for an experientially expedited means of understanding basic avalanche dynamics from a firsthand perspective. A typical patroller working control routes is exposed to the number of avalanches in a few months that a relatively avid backcountry skier may be exposed to over the course of several seasons.

While ski-patrolling is often a common path en route to becoming an Avalanche Specialist, it isn't mandatory and its relevancy varies as avalanches in the backcountry are, in many ways, very different from avalanches within ski area boundaries. That is, while ski patrollers are exposed to avalanches constantly and regularly, avalanches at ski resorts are in a controlled environment. The slopes are constantly compacted and stabilized by skiers' tracks and regularly controlled by patrollers using explosives and less impactive means of releasing avalanches. Not to mention the protocols that are in place to keep patrollers safe while conducting their control work.

In the backcountry none of this control exists. Avalanche expert Bruce Tremper (2008), director of the Utah Avalanche Center, has related avalanche phenomena within ski area boundaries to the controlled thrills of an amusement park...versus the savagery of avalanche phenomena in the backcountry. Mr. Trautman agreed that it is possible to gain a very well developed, and perhaps more relevant, understanding of avalanche phenomena through the backcountry setting alone; without ski patrol experience. However, this isn't typical.

Mr. Trautman also provided insight into the other traditional track into the Avalanche Specialist occupation. This is the academic track; specifically, graduate education and research at one of the few universities in the country that offer snow science programs typically through environmental or earth science departments. As Mr. Trautman has a Master of Science from such a program (Montana State University where he worked with NAC director Dr. Karl Birkeland), he was able to provide extremely relevant insight. The research projects that aspiring Avalanche Specialists have typically undertaken focus on a question or hypothesis relating to avalanche formation or dynamics and involve some degree of scientific field work that is common of such physical science research. However, although not currently as prevalent, Mr. Trautman said he thinks the future of the academic track will have more opportunities for research and projects characteristic of the social sciences in order to further inform an understanding of the human factors.

Meteorology & mountain weather:

Avalanche Specialists must have an understanding of meteorology, especially as it pertains to mountain weather; this is essential for understanding avalanche related phenomena. Multiple steps were taken in order to develop a strong meteorological foundation and understanding of mountain weather essential to effectively taking on this project. Basic meteorology texts were studied to further develop a general understanding of weather and climate, as well as texts specific to mountain weather focusing on implications for avalanche forecasting. Participation in a three day intensive mountain weather forecasting course provided by MountainWeather (of Jackson, WY) and offered through the Chugach National Forest Avalanche Information Center (CNFAIC), in addition to a semester long graduate level environmental science course in mountain weather and avalanche forecasting through APU, were also parts of this process.

Through the three day intensive mountain weather forecasting course an understanding of general meteorological concepts gained through prior independent study was refined and further applied to developing a working knowledge of mountain weather and implications for avalanche forecasting. Learning how to use a plethora of freely available weather forecasting products (tools), studying Southcentral Alaska weather patterns and their implications for avalanche terrain, an introduction to weather forecasting methods, and being provided with instructional exercises for further developing weather forecasting skills were other components of this three day intensive course. Forecasting skills, especially as they pertain to mountain weather, avalanche forecasting, and providing the recreating public with an avalanche advisory program, were further developed through the APU course, which involved more traditional academic study and research as well as extensive field work.

Valuable resources for developing meteorological literacy:

The Weather Book (Williams, 1997), one of the first texts studied, is a general meteorology resource used to brush up on basic concepts relating to weather and climate and in order to prepare for the intensive, three day mountain weather forecasting course. While being simple and easy to read, with exceptional explanatory illustrations and diagrams, chapters such as “Why the winds blow” review how air pressure differences put weather systems in motion and, specific to this project, provided initial insight into weather phenomena characteristic of Southcentral Alaska. For instance, initial insight was gained in regard to how air pressure differences between weather fronts are responsible for strong gap winds such as those that occur through terrain features like Turnagain Arm and can have serious implications for the avalanche terrain under consideration by this project.

Jetstream: Online School for Weather, a free resource provided by the National Weather Service (n.d.), provided another means of brushing up on basic meteorological concepts, reviewing for the three day mountain weather forecasting course, and preparing for this project. The section on doppler radar provided insight into the advantages, limitations, and effective use of such a tool (definitely one that is frequently employed by Avalanche Specialists). Likewise, the chapter on remote sensing provided insight into understanding and effectively using information from weather satellites, both geostationary (GOES) and polar orbiting (POES) technologies, and automated surface observing systems (ASOS).

Meteorologist Jim Woodmencey taught the intensive mountain weather forecasting course. He is also the author of the mountain weather specific text *Reading Weather* (1999), which informed practical methods and techniques for forecasting weather while in the backcountry (without the aid of advanced communications technologies), such as cloud watching and altimeter reading clues, that were essential for effective project field work. *Mountain Weather* (Renner, 2005) is another text that helped develop foundational knowledge of mountain meteorology and informed project field work. It provided techniques and strategies for preparing "pre-trip weather briefings" that aided planning in order to get the most out of time spent in the field. It also provides valuable sections with "regional weather guidance," one of which is pertinent to Alaska and provided a brief introduction into synoptic-scale weather patterns characteristic of Southcentral Alaska that affect avalanche terrain under consideration by this project.

Mountain Meteorology (Whiteman, 2000), the most technical text studied, was used as a reference source to further develop an understanding of concepts encountered elsewhere as well as the relationship between weather and avalanche phenomena. Papineau (n.d.), who was based out of the Anchorage National Weather Service (NWS) office for a significant portion of his career, authored an online mountain weather text that is available for free via the Anchorage NWS website. It is billed as a practical guide for hikers, climbers, and skiers; it was very relevant as such. Accident case studies reviewed by Papineau provided insight into how weather resources available to users of a recreational avalanche advisory program could help mitigate similar situations. Papineau also provides sections with regional weather surveys, one of which is specific to Alaska's mountains and provided further understanding of synoptic-scale weather patterns as well as climate and weather implications for the snowpack and avalanche related phenomena of the Chugach focused on by this project.

Snow Science Part 1 – Physical Science:

The field of snow science is relatively small. Geographically it is only relevant to portions of the globe. While recreation (at resorts and in the backcountry) has more recently become an additional driving force behind the development of the field, it was not the initial impetus and is one of many reasons the field exists. Nonetheless, snow science research conducted for the supposedly more vital purposes of transportation and commercial development can be applied to recreational avalanche forecasting programs. While there are several preeminent snow scientists worldwide, a couple stand out in this literature review for their contributions to the field that are widely applicable (especially to recreation): Jurg Schweizer of Switzerland and David McClung of Canada.

Schweizer's research greatly informed the approach to and methods of field work for this project, especially in regard to digging in the snow, analyzing the snowpack, and making inferences as to snow stability. Schweizer and Bellaire (2010) authored an article on strategies for stability sampling at the slope scale in order to effectively conduct snowpack stability evaluation on a given slope. The authors note that slope stability evaluation is often based on the results of a single snow pit and single stability test within a slope but point out that, due to spatial variability even at the slope scale, truly effective stability evaluation for just one slope would require numerous pits and tests (possibly more than 100). As it would be unreasonable to go to such lengths to assess the stability of a single slope, the authors studied an approach (or strategy) that they propose as reasonable yet effective: digging two pits at least 10m apart on a given slope and conducting two tests (such as the compression test) within each pit. This strategy allows for an analysis of variability both within a pit and across the slope. The authors highlight the importance of forecasting for instability rather than stability, due to human biases for recreational enjoyment, and suggest that the strategy of digging a second pit and conducting further stability tests is only necessary if the results of the first pit are mixed or indicate stability; if instability is found through the results of both tests in the first pit, heightened caution is justified, instability should be assumed, and further assessment is unnecessary: the slope isn't stable. However, if one or both test results in the first pit point to stability, this hypothesis should be questioned via a second pit and additional tests, to avoid the danger of a false-stable prediction.

Further informing and enhancing project methods for digging in the snow as a means of assessing stability, an article by Schweizer and Wiesinger (2001) explores snow stability evaluation via snow profile and stability test interpretation as an essential everyday function of avalanche forecasting programs. It proposes a snowpack stability rating scheme based on a survey of experienced Swiss forecasters' decision-making processes in regard to the importance they give to various parameters of snow profiles and stability tests. The study found that the primary evaluation criteria are stability test score, layer hardness, presence and type of weak layer(s), and grain size/type. Identifying key parameters through this study was done in an attempt to foster a more consistent means by which forecasters can interpret snow profiles and conduct snow stability evaluation. The authors reiterate the importance of conducting stability evaluation by searching for signs of instability, rather than stability, as mentioned earlier. Numerous intricacies of snow profile interpretation were brought to consciousness from this article, further informing project field work and understanding of avalanche forecasting practices.

Schweizer was involved in authoring six more important articles in terms of informing effective field work strategies for undertaking this project. Winkler and Schweizer (2009) conducted a study on the effectiveness and reliability of three common stability tests: the extended column test (ECT), compression test (CT), and rutschblock test (RBT). The discussion in this article provided a more sophisticated understanding of the pros and cons of each test and when each might be most effective to employ.

Schweizer and colleagues wrote two informative articles that review important concepts in avalanche forecasting. The first (Schweizer, 1999) takes a technical and scientific look at the dynamics behind the release of dry-snow slab avalanches. The second (Schweizer, Kronholm, Jamieson, & Birkeland, 2008), provides an overview of the snow science concept of “spatial variability” and its implications for avalanche forecasting. The authors suggest that spatial variability is one of the primary sources of uncertainty in avalanche forecasting and a risk-based, instability-biased approach to decision-making is the best method of managing this uncertainty.

Schweizer, McCammon, and Jamieson (2008) explore the three primary dynamics of dry-snow slab avalanche release (failure initiation, fracture propagation, and detachment of slab from margins). They explored three predictors of instability (stability test score, release type, and snow profile interpretation) in regard to their significance for predicting dry-snow slab avalanche release. Study findings suggest that all three predictors are highly significant, with release type being the single best predictor of instability (while also being the easiest predictor to interpret). Although predictors have some degree of varying significance, the importance of integrating all three, in addition to all other clues and observations related to stability evaluation, is emphasized.

To conclude the review of Schweizer's contributions to this project, an editorial for *Cold*

Regions Science and Technology (Schweizer, 2008) provides a general overview of avalanche formation and dynamics and supports this synopsis with a review of relevant research. The editorial highlights the importance of avalanche hazard mitigation programs for backcountry recreation in light of statistics revealing about 250 annual avalanche related fatalities globally. This assertion supports the importance of this project as most of these fatalities are due to accidents involving recreation on public land. As the popularity of backcountry pursuits such as skiing and snowboarding has been increasing rapidly in recent years, it's estimated that the number of fatal accidents will increase accordingly. The Anchorage Avalanche Center strives to help prevent fatalities and casualties in Anchorage area avalanche terrain that could be mitigated by the public having access to quality information on backcountry snow conditions that can aid decision making.

The research literature has some interesting findings pertaining to avalanche accidents and survival that are pertinent to this project. Grissom (2011) found that different geographic regions may have different avalanche survival patterns due to remoteness, terrain, and snow climate. Remoteness increases the response time of out-of-party help. Terrain differences can influence avalanche characteristics and trauma type. A wetter snow climate accelerates asphyxiation versus a drier one. A similar study (Grossman, Saffle, Thomas, & Tremper, 1989) found that survival is unlikely for victims of a complete burial, avalanche related trauma causes complex problems, and trauma and asphyxia are the primary causes of death. These studies' findings are relevant to the work of an avalanche center as far as informing a communication of hazards, educational efforts, and emergency response.

While risk factors are typically more of a social science concern, insight gleaned from the following article is more relevantly categorized in this physical science section. Grimsdottir and McClung (2006) analyzed several avalanche risk factors involved in backcountry skiing and ranked them according to their significance: stability rating, elevation, time of year (early-mid vs. late season), and aspect. The significance of elevation, as it pertains to terrain above and below treeline has interesting implications for this project's avalanche forecasting, as the study found that alpine terrain is relatively higher risk terrain due to factors such as higher rates of precipitation, higher wind speeds, and lack of forest cover to break up slabs and impede avalanche start zones. While this project's avalanche terrain isn't high elevation, due to its northern latitude the majority of Front Range and Eagle River area avalanche terrain is alpine.

Two more important articles conclude the physical science section of the literature review that informed this project. The first is by Jamieson, Geldsetzer, and Stethem (2001) and focuses on forecasting for deep-slab avalanches, a type of avalanche that is both notoriously dangerous and difficult to forecast. The authors argue that deep slab avalanches may be initiated in thin spots of the slab. They rank the most significant predictors of deep slab natural avalanches, according to the parameters of their study, in this order: previous avalanche activity, accumulated snowfall over several days, air temperature change over 4-5 days, snowpack properties such as shear frame stability index, and the difference in hardness between the facet layer and crust (critical failure interface in their study). As Southcentral Alaska experienced meager early season snowfall followed by extended periods of high pressure at the beginning of the 2012-13 season, creating optimal conditions for deep slab instabilities in some areas (mainly eastern Turnagain Arm and the Kenai Peninsula), the learning gleaned from this article enhanced an understanding of what might have been a too often ignored and relatively difficult to forecast avalanche problem.

The final article, by Mock and Birkeland (2000), focuses on “snow avalanche climatology” of U.S. mountain ranges. Research from the late 1940s (Roch, 1949) and mid 1960s (LaChapelle, 1966) first proposed three snow avalanche climate zones for classifying the world's mountains. Slightly revised from the originally proposed classification system, the three climate zones have more recently been refined as the coastal (maritime), intermountain (transitional), and continental zones.

The Western Chugach, part of which this project piloted and implemented a recreational avalanche advisory program for (Front Range and Eagle River area), has great climate zone variability within it. The core advisory areas focused on by this project don't fit well within any of the three climate classifications, but a deeper understanding of the characteristics of each climate zone and how the climate zone of an area can vary from season to season, especially in an area as dynamic as the Western Chugach, was gained from this article and has further developed the knowledge base for undertaking this project.

Snow Science Part 2 – Social Science:

How do people make decisions in backcountry avalanche terrain, what are the risk factors involved, what can be learned from survival patterns, and are there rule-based decision-making tools that can enhance safety and mitigate risk? These are some questions explored by the social science literature reviewed in preparation for and in order to inform this project. Common names in the field of snow science, introduced in the previous section, reappear.

In his two-part journal article on “the elements of applied avalanche forecasting” McClung (2002), author of a classic avalanche text mentioned earlier (*The Avalanche Handbook*), is credited with the first formal attempt to integrate human factors into what was previously seen more exclusively as a geophysical problem. Prior to McClung's treatise is this two-part article, avalanche forecasting had formally been framed as “a geophysical problem with respect to the state of stability of the snow cover.” McClung broadens this framework and describes avalanche forecasting as a complex process involving seven interconnected elements that must all be mastered for optimal forecasting. McClung frames forecasting as a dynamic problem involving variations and interactions between a human and natural system. He points out that “since most avalanche accidents result from human errors, no description of avalanche forecasting is complete unless the human component is addressed.”

Part one focuses on aspects of avalanche forecasting more characteristic of the social sciences: “the human issues” (four of the seven interconnected elements). He provides an important discussion of what is known within the snow-avalanche industry as the “Operational Risk Band (ORB).” The ORB is framed within a broader discussion of a risk-decision matrix for backcountry skiing that concerns the balance of risk versus reward.

Part two focuses on aspects more characteristic of the physical sciences: “physical issues and the rules of applied avalanche forecasting.” Three of seven interconnected elements (information that goes into making a forecast, time and spatial scales for applied forecasting, and physically based decision-making rules for backcountry travel) in avalanche forecasting are explored. Key points are that data used in forecasting come in multiple forms (numeric, symbolic, judgmental), data may be classified according to its influence on human perception of stability/instability, forecasting includes both singular and distributional data, forecasting is a multi-scale problem in time and space, correct forecasting decisions should fall within the ORB (neither too risky or conservative), and that forecasting requires a degree of formalized decision making to counteract human biases. McClung provides an appendix with this article that includes ten rules of applied avalanche forecasting. This two part article was undoubtedly one of the greatest literary resources for informing this project. It provided a much deeper understanding of what avalanche forecasting is and entails.

Another, more recent, McClung (2011) article discusses avalanche forecasting in terms of perception of evidence. He juxtaposes stability analysis and instability analysis as two biasing modes of perception when forecasting. McClung frames stability analysis as the favored hypothesis for “good recreational enjoyment” while the null hypothesis, instability analysis, is the “best framework for avalanche forecasting.” The hypothesis, or mode of perception, used is important “because it conditions data sampling and travel decisions.” The essence of the article is summed up in McClung's insightful remark that "instability analysis puts the emphasis on targeted sampling to be aware of … likely places for triggering avalanches based on the terrain. Since human perception is the root cause of human-triggered accidents, this mindset is important since it governs data sampling, which is the key conditioner of human perception." This article echoes the importance of forecasting for instability rather than stability, as mentioned throughout this literature review, and exponentially enhanced an understanding of the implications of avalanche forecasting.

Risk in winter backcountry travel was further explored in another article (Silverton, McIntosh, & Kim, 2009) that identified snowshoers and snowmobilers as the most likely user groups to underestimate avalanche danger. Thus, efforts should be made by concerned organizations to increase the awareness level of these user groups. The findings of this study are significant for this project as the Front Range and Eagle River area Chugach sees significant snowshoe (and winter hiking) traffic in its avalanche terrain, as compared to other popular winter recreation areas in the state more exclusively visited by snowmobilers, skiers, and snowboarders. In years with adequate snowfall this project's advisory areas also see significant snowmobile traffic. Extrapolating from this research, these two user groups could benefit immensely from the recreational avalanche advisory program this project piloted and implemented.

To conclude the literature review of the snow-avalanche social science that informed this project an important study that evaluated rule-based decision tools for travel in avalanche terrain, conducted by McCammon and Hageli (2007), is worth mentioning. The authors highlight the importance of slope scale avalanche forecasting skills for recreationists' safe travel in the backcountry. As these skills have long been recognized as difficult to develop, a number of rule-based decisions aids have been devised to aid decision making. This study describes and analyzes five of those decision aids based on how they would have performed if they had been employed by parties involved in 751 historical avalanche accidents in the United States. The findings suggest that use of the decision aids analyzed could have prevented from 60-92% of these accidents. Decision aid factors the authors were concerned with included accident prevention, ease-of-use, and mobility. They found that a "decision aid based on a simple checklist of obvious clues" provided the optimal balance between the aforementioned factors. An avalanche advisory program could benefit from providing such tools to users. Additionally, it is interesting to consider an avalanche advisory itself as a decision aid tool.

Industry standards & guidelines:

Three important documents provide the closest semblance to industry standards for avalanche related operations and programs in the United States: *Snow, Weather, and Avalanches: Observation guidelines for avalanche programs in the United States,* commonly referred to as *SWAG* (Greene et al., 2010), the *USDA Forest Service National Avalanche Center Backcountry Avalanche Program Business Plan* (USDA, 2001), and the *USDA Forest Service National Avalanche Center Backcountry Avalanche Center Operational Guidelines* (USDA, 2012). These documents were referenced intensively during the course of this project; *SWAG* for advisory production purposes (field work documentation and writing advisories); the NAC business plan and operational guidelines provided structural ideas and a starting point for developing a grassroots recreational avalanche advisory program.

Four types of avalanche centers in the United States:

The NAC business plan and operational guidelines classify four types of avalanche centers operating in the United States and provide an outline, or structure, for each. *Type 1 Regional Centers of Excellence* are the most developed, well-funded, and infrastructure intensive. The Chugach National Forest Avalanche Information Center (CNFAIC), the only USFS center in Alaska, recently became Type 1. In addition to providing the most and highest quality avalanche information, these types of centers "provide expertise to their regional office and also to the other avalanche centers in their region" (USDA, 2012). Thus, they are supposed to work with less developed avalanche centers, such as the AAC, in order that they develop into viable and sustainable entities. *Type 2 Regional Centers* are also well-funded and employ multiple full-time seasonal staff, however they're a step down in funding, infrastructure, and staffing as compared to a Type 1 center.

Type 3 Local Avalanche Information Centers, most characteristic of the AAC during its 2012-13 season operations, typically employ at least one full time Avalanche Specialist or Avalanche Coordinator (a position requiring less experience than Avalanche Specialist). A Type 3 center "issues weekly or twice weekly avalanche advisories, provides public avalanche education, acts as a local media contact, collects snowpack stability data, and provides a platform for the exchange of snow, weather, and avalanche information that benefits public users and other avalanche safety programs" (USDA, 2012). A Type 3 center typically has a seasonal budget of about $30,000 (USDA, 2001). This is the proposed, long-term sustainable budget for the AAC (see Appendix J, pg. 69).

Type 4 Local Education Centers, the NAC recommended starting point for an avalanche center effort (due to requiring the least amount of funding, infrastructure, and staffing), do not issue advisories but do provide avalanche awareness education to the public and an informal platform for the exchange of backcountry snow information (USDA, 2012). The Type 4 model was deemed a less desirable starting point for this effort due to a number of already well-established avalanche education providers in the Anchorage area (Alaska Avalanche School, Alaska Pacific University, Backcountry Babes, North America Outdoor Institute, CNFAIC). Another entity in the area focused primarily on providing avalanche education seemed like it could infringe on these already well-established avalanche education providers and it's doubtful the educational offerings of a Type 4 center would be a significant or improved contribution to the public from what's already being offered locally. What's most needed for the Front Range and Eagle River area Chugach is organized and professional information on backcountry snow-avalanche conditions: an advisory program. While the funding, infrastructure, and (paid) staffing for a Type 3 center hasn't been fully secured for this project, the operations characteristics of a Type 3 center seemed a more appropriate public service and contribution to the local backcountry community.

Avalanche centers in the United States (the vast majority being Forest Service) most often take many years to develop from a basic level to the operational capacities of Type 2 or 1 centers. As there are a few non-government avalanche centers in the country that are developed beyond the Type 4 level, but don't always have the (paid) staffing and sustainable funding the NAC suggests is necessary for a Type 3 center, there has been some controversy as to these centers' methods and operations (Karl Birkeland – Director of the National Avalanche Center & Pete Carter – Director of the Alaska Avalanche Information Center, personal communications, spring 2013).

Avalanche center informational products:

The NAC business plan is an earlier document that attempted to provide industry-standard definitions pertaining to avalanche center operations, such as differentiating between "daily avalanche advisories" and "avalanche information advisories" For instance:

> Daily avalanche advisories are issued by individual avalanche centers and they typically contain a mountain weather forecast, a synopsis of current avalanche conditions, and a danger rating as defined by the U.S. Avalanche Danger Rating Scale. Daily avalanche advisories should be posted by 08:00. Daily advisories should be based on daily snow pack and weather observations including data from the preceding 48 hours. Data used for the advisories may come from:
>
> 1. Backcountry and/or ski area snow pack analyses and observations (the data may come from avalanche center personnel, ski area personnel, other agency personnel, or trained public or volunteer observers)

2. NRCS SNOTEL and snow course data,
3. Mountain weather stations,
4. National Weather Service forecasts and related information, and
5. Weather and snow pack models

> Avalanche information advisories consist of the same elements found in avalanche advisories but the content is more general. Information advisories may or may not include a mountain weather forecast. Information advisories describe current avalanche conditions but an avalanche danger rating is not provided for the current conditions. An exception is when avalanche conditions are obviously high or extreme. When this occurs the avalanche coordinator may issue an avalanche warning. Data used for the information advisories may include much of the same data as avalanche advisories but typically the data are not as detailed. (USDA, 2001)

The NAC has since updated its distinction between these different types of avalanche information products. In the more recent operational guidelines (USDA, 2012), it defines “daily avalanche advisories”, “weekly or semi-weekly avalanche advisories”, and “avalanche information bulletins.” “Daily avalanche advisories” are still described the same as in the 2001 business plan. The “weekly or semi-weekly avalanche advisories” contain similar content to the “daily avalanche advisories,” but danger ratings are not a necessary component and they're not issued daily. “Avalanche information bulletins” are less detailed, do not contain a danger rating, and are appropriate for when more limited snowpack data is available (USDA, 2012).

Observation & documentation guidelines:

The *SWAG* was developed primarily by the American Avalanche Association and the National Avalanche Center to provide details in regard to observation and documentation guidelines for snow, weather, and avalanches. Like the *North American Public Avalanche Danger Scale* (see Appendix A pg 60), developed by practitioners from across the continent (United States and Canada) involved in the snow-avalanche industry, the *SWAG* isn't the sole work of the USFS NAC. Rather, it was developed in coordination with professionals representing a spectrum of occupations in the snow-avalanche field.

Standardized instructions for conducting snow stability tests, recording the results, and documenting weather and avalanche observations are provided. For example, Anchorage Avalanche

Center professional observations include photos and descriptions of avalanches that are coded according *SWAG* standards:

> *This is the most inherently large and destructive avalanche observed since the O'Malley avalanche that occurred around the first of April. Starting at ~4000' and running ~1000' this slab avalanche, likely triggered by wind loading and solar radiation late Friday in a relatively thin area of the snow-pack, pulled out snow down to the ground and the debris ran up and over the gully terrain trap at the slope's base (SS-N-D3-R2):*

(Fig. 1)

(Fig. 2)

These photos (screenshots from the Anchorage Avalanche Center website), show a recent avalanche coded as SS-N-D3-R2. This stands for a soft slab (SS), natural (N) avalanche that is size three on the five point destructive force scale (D3) and size two on the five point size relative to path scale (R2). To put this in perspective, according to the *SWAG* avalanche destructive force scale:

D1	Relatively harmless to people	typical path length of 10m
D2	Could bury, injure, or kill a person	typical path length of 100m
D3	Could bury and destroy a car, damage a truck, destroy a wood frame house, or break a few trees.	typical path length of 1000m
D4	Could destroy a railway car, large truck, several buildings, or a substantial amount of forest.	typical path length of 2000m
D5	Could gouge the landscape. Largest snow avalanche known. (Greene et al., 2010)	typical path length of 3000m

Prior work conducted towards this project's goal:

The literature review concludes with a brief look at another APU effort that set the stage for this project. In 2010 APU undergraduate Jon Gellings conducted a Chugach State Park (CSP) avalanche center feasibility study. Important findings from the feasibility study and implications for this project include “determining visitor use, public support, and what infrastructure would be needed to start and continue operations.”

Gellings surveyed 272 people and found that “an overwhelming majority think that there is a need for an avalanche information advisory program, and want/would use the service if it was provided.” The survey identified four areas receiving frequent recreational use: the Rabbit Creek and Powerline valleys (accessed from Canyon Road and Glen Alps trailheads), the South Fork Eagle River valley, and the backcountry terrain in the vicinity of the Arctic Valley ski area. Identification of these four areas informed selection of the core advisory areas for this project. Gellings survey further suggests that the majority (72%) of respondents would be willing to make a donation of between $1-50 per year to provide for a recreational avalanche advisory program that they felt should be provided by a partnership between the state (Alaska State Parks – CSP) and a non-profit group. Gellings' study envisioned a program that would start with one full-time employee issuing advisories two or three days a week; a program that would initially be feasible according to the NAC model for a Type 3 center “with room to expand in the future.”

Methods

This section on methods explores project development from initial planning for piloting the avalanche advisory program through a non-public trial period to going live as the Anchorage Avalanche Center and making the program available to the general public.

Initial planning:

This project was initially conceived during the 2010-11 snow season, in hopes of furthering prior work towards developing an avalanche advisory program for the Front Range and Eagle River areas. During the 2011-12 academic year a proposal to pilot, and possibly implement, a grassroots and minimalist model for a recreational avalanche advisory program serving this area was submitted to APU Outdoor Studies (OS) faculty.

Limitations of the NAC model:

Gellings' (2010) feasibility study had primarily relied on the NAC business plan for structuring a Chugach State Park advisory program. Truly adhering to this model of development required significant initial funding, infrastructure, and resources. Some stakeholder organizations that could be primary forces behind implementing and sustaining such a program wanted to ensure the necessary funding, infrastructure, and resources would be available and prospectively sustainable before they'd take any substantive action. Based on these hard to acquire prerequisites, it was clear nothing would happen in the near future without a more grassroots catalyst.

As the vast majority of avalanche related accidents in the Lower 48 occur in avalanche terrain on public land managed by the Forest Service, the appropriateness of the Forest Service providing for backcountry avalanche information there is easily understood. However, land management implications for Alaska's avalanche terrain have created very different circumstances (see discussion section, pgs. 42-43, for more on this). Much of Alaska's avalanche terrain that is popular with recreationists is on public land managed by local, state, and federal government agencies other than the USFS that lack the protocol for providing the public with backcountry avalanche information for primarily recreational purposes.

Such is the case for the avalanche terrain under consideration by this project, which is managed by CSP. CSP deals with a very tight budget. The lack of a recreational advisory program to provide information for its extensive avalanche terrain is not a priority problem for which CSP is actively seeking a solution.

Adhering to the NAC model for starting an avalanche center serving the Front Range and Eagle River area Chugach (part of CSP) seemed too cumbersome and this avalanche terrain isn't managed by the USFS. Thus, it wouldn't be able to lean on existing USFS infrastructure and resources for initial support. Something minimalist and grassroots was required.

As an example, a non-government avalanche center was taking off for the popular Hatcher Pass area that is about an hour to the north of Anchorage. The HPAC is set up as a very small non-profit. It provides recreational avalanche information, through a weekly advisory issued on Saturday mornings (the day perceived with the most recreational use) for land managed by Alaska State Parks; a land manager with extensive avalanche terrain in Southcentral Alaska that is frequented by recreationists, but lacks the protocol, infrastructure, resources and budget for providing organized avalanche information for its visitors.

The need for a grassroots, minimalist approach:

Considering the aforementioned, a grassroots and minimalist approach to providing a recreational avalanche advisory program for the Front Range and Eagle River area Chugach was thought to be, at least initially, the only realistic way for this sort of program to come to fruition considering the limited resources available to support it in the near future. Thus, the main goal of this project was to provide an example of a grassroots, minimalist model recreational avalanche advisory program that produces regular weekly avalanche advisories (issued Saturday mornings) targeting the Front Range and Eagle River area's most popular avalanche terrain. As with the Hatcher Pass area, this model would attempt to show that an avalanche advisory program doesn't necessarily have to be provided by a government land manager. Although, eventually it would be a great asset for State Parks to invest and be a provider of resources.

Stakeholder identification and outreach:

The first, more formal efforts towards making this project a reality were identifying and then meeting with community stakeholders. First and foremost, this project's primary stakeholder is the recreating public. The whole point of this project is to increase the awareness and improve the safety of users of Chugach State Park's most popular avalanche terrain. The general public has a lot to gain from (increased awareness for better decision making) and contribute to (observations and donations) this project. However, in order to develop this project into a viable and sustainable institution, the focus here is on developing a consortium consisting of local government agencies, organizations, and businesses (with ties to backcountry recreation in avalanche terrain) capable of supporting, sustaining, and developing this project.

Numerous stakeholders were initially identified including Alaska Pacific University (APU), Alaska Avalanche School (AAS), Chugach National Forest Avalanche Information Center, Friends of the Chugach National Forest Avalanche Information Center (who have had as a stated goal addressing the absence of organized avalanche information for the Front Range and Eagle River area Chugach), Friends of Chugach State Park, Chugach State Park Citizen's Advisory Board, Chugach State Park administration, Alaska Mountain Rescue Group, and Anchorage Nordic Ski Patrol.

Primary stakeholders:

Those initially contacted for a meeting to discuss the project further were CSP superintendent Tom Harrison, the Chugach State Park Citizens Advisory Board (CSPCAB), Chugach National Forest Avalanche Information Center (CNFAIC) staff, and the board of directors of the Friends of the Chugach National Forest Avalanche Information Center (F-CNFAIC). As the avalanche terrain under consideration by this project is managed by CSP, the state park was an obvious primary stakeholder. As the CSPCAB plays a key role in CSP decision-making, they were introduced to the project early on as well. Finally, F-CNFAIC was contacted and the project pitched to them as they're partnered with the Forest Service to provide sustenance for the only well-funded avalanche center in the state: the CNFAIC.

A meeting with CSP superintendent Tom Harrison revealed no opposition to this project's goal: the development of an advisory program for CSP avalanche terrain (personal communication, spring 2012). The catch was that CSP had no money or resources to invest in such a program. Mr. Harrison attempted to explain the limited resources available to Alaska State Parks, specifically Chugach State Park, and how it's doubtful resources could be allocated to an avalanche advisory program in the near future.

However, it is worth mentioning that providing for an avalanche advisory program such as that envisioned by this project is pennies compared to more expensive projects (construction and trail building) that CSP engages in with some frequency. The need for a CSP avalanche advisory program is arguably as dire a need as any other for which expenses are approved. After all, Mr. Harrison himself stated that avalanches are CSP's number one threat (more than bears, for example, for which resources are allocated to mitigate the hazard). He also mentioned that the CSP office received relatively frequent calls around the time of winter storm events about avalanche conditions in the park. In the end, CSP was on board (supportive) so long as, if this project went public, it was clearly done so exclusive of CSP involvement.

The need for a consortium:

During another meeting with Blaine Smith (a CSP employee, experienced mountain and snow-avalanche professional, and former director of AAS), it was suggested that the consortium mentioned earlier may be the only way to address the viability and sustainability for a CSP advisory program (personal communication, spring 2012). As mentioned, this consortium model would bring together local stakeholders invested in avalanche education, public safety, and the development of winter outdoor recreation opportunities in the greater Anchorage area. The idea was that, by working together, these varied stakeholder organizations could pool together enough resources to support and sustainably fund the program and its future development.

As the F-CNFAIC, in part, provides for the CNFAIC and has experience developing an avalanche center from scratch to relative success, their help was requested. While the NAC business plan and operational guidelines were still under development when the CNFAIC started in 2000, it basically followed the NAC model from its inception as a center characteristic of Type 4 operations to its current manifestation as a Type 1 Regional Center of Excellence. As the F-CNFAIC has already developed the community connections and support necessary for CNFAIC viability and have had as a stated goal addressing the absence of organized avalanche information for the Front Range and Eagle River area Chugach, the CNFAIC and F-CNFAIC have much to offer this project. Their expertise in fundraising and community outreach, help rallying backcountry enthusiasts for Anchorage area field observations, feedback and critique of the project for assessment and quality control purposes, and otherwise general support with avalanche center operations and programming could be a great boon to the Anchorage Avalanche Center effort and the Anchorage area backcountry community.

Planning the final details:

A few final details needed to be ironed out before the project could begin. Namely, liability and quality control dilemmas if the project was to go live and actually provide the public with information on backcountry snow conditions for the Anchorage area. The problem of going public was exacerbated by the fact that APU's designated snow science faculty, Eeva Latosuo, was to be on sabbatical the academic year this project would be conducted; she would be unavailable to provide necessary oversight. Less of a focus was placed on actually implementing the program and making the information it produced available to the public. Instead, the focus shifted to piloting the model for review by primary stakeholders and potential members of the consortium. They would be able to provide critique and feedback for quality control and development purposes, in hopes that the project could eventually go live and be made available to the public.

Initial project overview:

From personal experience, common local knowledge, discussion with prominent local backcountry skiers and snow-avalanche professionals, and Gellings' (2010) feasibility study, two zones with five access points were identified as receiving heavy wintertime use primarily by backcountry skiers and snowboarders: Canyon Road, Glen Alps, Arctic Valley, and the South Fork and Hiland Road areas of Eagle River. These areas were deemed CSP's most popular avalanche terrain. Thus, they comprised the core advisory area (see Appendix E, pg. 64) for producing the weekly avalanche advisory.

Implementing the avalanche advisory program and producing the weekly advisories was initially undertaken as a pilot study; the information produced would not be available to the public at large for the sake of liability, quality control, and the development process. However, the project was undertaken as if the advisories produced were actually available to the public. That is, collection of snow, weather, and avalanche observations (acquisition of field data) necessary for producing the weekly advisory, in addition to writing the advisory and posting it online, was all undertaken as if it was really available to the public on Saturday mornings by 7am.

A website was developed for sharing Front Range and Eagle River area avalanche information and posting a weekly (issued early Saturday morning) recreational avalanche advisory. This was done according to the NAC business plan and operational guidelines for weekly avalanche advisories. The website included weather resources, webcams, project information such as the advisory area/forecast zone, professional observations, etc. It was designed to be straightforward and easy to use. The design elements were derived from a considerable amount of time spent reviewing the websites of avalanche centers across North America, as well as taking into account website development limitations according to a grassroots and minimalist approach.

Initially, the website was password restricted and only identified local professionals in the snow-avalanche industry, stakeholders, and some advanced local recreationists were given access in order to provide feedback for project assessment, as well as for quality control and development purposes. The initial, non-public website was chugachfront.wordpress.com (see Appendix M, pg. 81). It later changed to www.anchorageavalanchecenter.org (see Appendix N, pg. 82) when the project went public. The necessary field work for producing the weekly avalanche advisory was conducted with volunteer partners and an APU undergraduate student.

Working with undergraduates:

Working with APU undergraduate students was another component of this project. It was initially planned as a directed study course (*OS380: Field Work in Snow Science* – see Appendix K, pg. 70, for syllabus) for those on the snow science curriculum track to get experience in the absence of the standard courses while Ms. Latosuo was on sabbatical. This would also provide additional partners for field work in order to gather the sufficient snow and weather observations that are necessary for producing a reliable and accurate advisory.

This opportunity would provide these undergraduates with hands-on experience collecting snowpack data, taking field observations, synthesizing this information, and integrating it into a written avalanche advisory. They would learn how field data is collected and documented according to national standards, how this information is applied to avalanche forecasting, and improve their winter backcountry travel skills. Furthermore, this experience would be a valuable opportunity for the project designer to gain outdoor, avalanche, and higher education teaching experience.

Initial screening of APU undergraduates interested in helping with this project was undertaken in order to determine their level of preparedness (they needed to have already developed at least intermediate avalanche awareness and winter backcountry travel skills). Several students expressed interest and a few were enrolled in the directed study course. However, last minute constraints and other more pertinent priorities to these students' pending graduations left only one remaining.

The remaining student had different needs than what could be provided by OS380. After discussion with Outdoor Studies faculty she was granted permission to receive credit for *OS325: Snow Science for Outdoor Professionals 2* as a directed study, in part working as a field assistant to help with this project. As this course would be instructed without remuneration, it was able to happen with only one student enrolled.

Risk management:

The risk management protocols were undertaken for both independent field work as well as working with an undergraduate student in the field. Considering prior experience developing Risk Management Plans (RMP's), the process was familiar. A working RMP document, from past occasions doing independent field work in avalanche terrain, was modified and updated. After a few drafts and answering a host of questions from the APU Off Campus Risk Management Committee, the RMP was approved. It included a project description and overview, identification and mitigation of potential risks and hazards, protocol for field days and associated communication, list of qualified partners (credentials and contact information), and emergency response plan. See Appendix L (pg. 74) for the full RMP document. More information on risk management can be found at the bottom of the next page.

Final preparations before field work commenced:

The fall semester of 2012 was spent getting everything in place to officially start the project in the spring semester (January 2013), as well as undertaking some final preparations for effectively conducting the project. As mentioned in the literature review, this included an Alaska Winter Weather Forecasting course and an independent study course through APU on mountain weather and avalanche forecasting. The APU course included studying mountain weather texts and snow science research articles, point specific weather forecasting exercises, and independent field work focusing on weather and avalanche observations.

All of Southcentral Alaska experienced meager early season snowfall followed by sustained high pressure systems (clear and cold weather) that faceted the snowpack so extremely as to ruin early season skiing and create deep slab instability problems in some areas (as discussed in the literature review at the top of page 16). Resultant conditions haunted recreationists for months. Nonetheless, field observations for this project began being collected as soon as the snow started falling.

Field work strategy:

Field work for this project was conducted independently with volunteer partners and an APU undergraduate student. However, due to unforeseen challenges with the undergraduate's level of preparedness and engagement, field work assistance from the undergraduate student didn't happen as planned (more on this in the discussion section on page 49). Thus, the majority of field work occurred with assistance from experienced ski partners listed in the RMP.

Several full days were spent in the field each week in order to gather sufficient data for developing the informational products released via the project website. As part of the project proposal, a commitment was made to spend at least two full days in the field each week taking observations and conducting snowpack analysis. This was the minimum deemed necessary for producing a reliable and accurate weekly advisory with a danger rating and fit with a model that employed one full time staff to provide for the avalanche advisory program envisioned. During the two or more field days per week, the best efforts were made to visit each of the two zones that comprised the core advisory area (see Appendix E, pg. 64, for map) and to spread out the field time equally between the northern and southern avalanche terrain under consideration.

Field days were accompanied by at least one partner, either the APU undergraduate or a qualified volunteer, and adhered to the project's RMP (using the APU electronic field trip planner, establishing an in-town contact for checking-in at the beginning of the day and checking-out at the end of the day, following the plan set for the day and provided to the in-town contact, etc.). Days of the week and times for the field days varied based on participant availability, snow and weather conditions, and other circumstances. However, they were conducted as to provide the best possible information for the Saturday morning advisory.

The field days consisted of meeting with partner(s) by late morning and driving to the advisory area(s) for the day. For primarily two reasons, field days emphasized quick assessment on the move rather than more intense snow science. First, field partners were volunteers helping with this project during their time off work. They wanted to ski, not dig more than necessary and be nerdy about the snowpack. A partner for field days was mandatory for risk management, so field days had to be structured so as to be appealing and satisfying for these volunteers. Nonetheless, in order to ski safely, the snowpack had to be assessed adequately – which would provide very useful information for observations and the advisory.

Second, in accordance with a grassroots and minimalist model for a program employing only one full time staff, a lot of ground needed to be covered in order to assess an extensive snowpack; there were five access points for two zones comprising the core advisory area (see Appendices D & E, pgs. 63-64, for maps) to be assessed weekly each of which are separated by a 15-45 minute drive and some of which require at least a fifteen minute approach just to reach the lower elevation avalanche terrain. While a more developed avalanche center may have the time and resources for more intense and in-depth snow science, and can allocate field days and time accordingly, the approach to field work for this project is in line with the methods of effective USFS avalanche centers as evidenced by having accompanied their staff on field days.

This approach did not provide the more intricate data that comes from time consuming pit profiles through which layers can be identified and snow metamorphism monitored over the course of a season, which is dependent upon an operation with more staff and thus more time in the field. However, it did allow for covering a lot of ground, widely surveying the snowpack, and assessing conditions with limited time, manpower, and observations from the public (as the project wasn't yet available to the general public and observations could not yet be solicited from them). In addition, as observations began being collected as soon as the snow first started falling and the state of the snowpack tracked consistently throughout the season, day to day and from one weather event to the next, this provided a good idea of what was going on beneath the snow surface without needing to dig extensively for in-depth looks – rather focusing on quick pits and taking a closer look as needed.

It is also worth mentioning that the avalanche terrain under consideration by this project has an extremely high degree of spatial variability. Relatively speaking, the Front Range and Eagle River area Chugach snowpack has little consistency. Even on just one slope, the degree of spatial variability can be dramatic. As a lot of the skiing in the Front Range isn't exactly on slopes but rather in wind loaded gullies and other deposition areas where the snow is sufficiently deep enough to cover rocks, tundra, and provide for pleasant recreation, the snowpack can be radically different within just a few square feet. For all of these reasons, digging extensively for in-depth looks seemed like a less effective and efficient means of assessing snowpack stability for the terrain under consideration by this project. Rather, the quick assessment on the move emphasis (which included pole probing, hand pits, assessing low consequence test slopes, ski-cutting, cornice dropping, digging quick pits with standardized stability tests, and taking more in-depth looks with snowpack layer analysis as warranted) was preferred.

Writing the weekly advisory:

Following the field days, Friday evenings and early Saturday mornings were spent preparing the weekly avalanche advisory. Integrating everything observed and documented during field days in addition to examining snotel and mountain weather station data, weather (past, current, and forecast), and observations from others, was the first step in the process of writing the weekly advisory. While the advisories were only a few paragraphs long, they were very time consuming to create due to the need to distill a plethora of data and experience into a succinct communication that could be easily digested by the public. The advisory was structured with both avalanche laymen and more advanced users in mind. The most important information and communication of dangers was presented first, followed by increasingly detailed and specific information that would be of interest to the more advanced users of the advisory product.

In the advisories written during the early part of the project, a *North American Public Avalanche Danger Scale* rating was provided (but without the danger rating icon) along with a bottom line, primary concern(s), secondary concern(s), and further discussion. This approach was modified from the CNFAIC advisories to be appropriate for an operation with one full time staff in the field two plus days a week. This method was in accordance with the NAC guidelines for a weekly avalanche advisory or an avalanche information bulletin.

The recording of professional quality field observations for the project began in late December 2012 with a slow start due to minimal snowfall. By early January 2013 they were being collected in earnest, although the snowpack was still very thin and barely ski-able. By mid February conditions near Anchorage had improved, there was sufficient snow for increased recreation, and the first advisory (available only to identified stakeholders, snow-avalanche professionals, and advanced recreationists) was issued on Saturday, February 16. For the next several weeks, advisories were issued on Saturday mornings via the access-restricted website http://chugachfront.wordpress.com/ (see Appendix M, pg. 81).

Partnership with the Alaska Avalanche Information Center (AAIC):

Happenings around the time of Spring Break 2013 (early March) significantly changed the nature and direction of this project. It started with preparations for a trip to explore new terrain in the Thompson Pass area of the Central Chugach near Valdez, AK. In an effort to gain as much information on the prospects for quality skiing in this area during the week of Spring Break, the Valdez Avalanche Center (VAC) was contacted.

Surprisingly enough, considering all the networking with the snow-avalanche professional community local to Anchorage and discussing with Ms. Latosuo the need to understand the operations of various avalanche centers in Alaska and beyond as part of this project, there had been no mention of the VAC (a grassroots and non-government avalanche center that is the primary source of snow-avalanche information for the Central Chugach) and its umbrella organization: the Alaska Avalanche Information Center (AAIC).

When informed about this project the VAC founder-director Peter Carter, also founder-director of the AAIC, was very interested and supportive. Plans were made to visit him and other VAC/AAIC staff while in the Valdez area. Mr. Carter took time in the days leading up to this visit to review work completed on this project thus far and to provide his detailed feedback. It was also discovered that the AAIC was providing the non-profit status and liability insurance coverage for the aforementioned grassroots avalanche center for the Hatcher Pass area that, in part, inspired this project.

Mr. Carter was impressed with efforts on this project thus far and made it clear that the AAIC would fully support the effort with non-profit status and liability insurance coverage, just as it had for the HPAC, in order that it go public as the Anchorage Avalanche Center. The Anchorage Avalanche Center would be part of the AAIC along with the VAC, HPAC, and a couple other grassroots avalanche centers in the state (one in Cordova and one in Haines). Further details were discussed with Mr. Carter and plans were made for him to meet with APU faculty and other primary stakeholders the next time he came to Anchorage.

The AAIC, just as the F-CNFAIC, had long been interested in making an avalanche advisory program for the Front Range and Eagle River area a reality. However, primary hindrances for the AAIC weren't questions of sustainable funding, infrastructure, and resources. The AAIC didn't view these as prerequisites for an avalanche advisory program, as the AAIC isn't beholden to the NAC model and is of a more grassroots persuasion. The primary hurdle the AAIC encountered in making a Front Range and Eagle River area project happen,was finding an individual willing and committed to undertaking the effort – initially in a volunteer and pro bono capacity.

Going public as the Anchorage Avalanche Center (AAC):

Mr. Carter came to Anchorage mid-March 2013 for a DOT conference (his full-time paying job is the state of Alaska's Department of Transportation Avalanche Specialist for the Thompson Pass and Valdez area) and made time to meet with APU Outdoor Studies faculty and other primary stakeholders about making this project available to the public. OS faculty were initially resistant to the idea; quality control and liability needed to be further addressed if the project was to be public and in anyway connected to the university. They didn't see a way to adequately address these concerns in the short term. OS faculty also had issues with the possibility of getting dragged into Alaskan avalanche politics by supporting this project going public through the AAIC. In the meantime, Mr. Carter met with other branches of the Anchorage snow-avalanche professional community and CSP administration about going public with this project.

Following more meetings and further discussion with OS faculty, an agreement was reached that the field work portion of this thesis project would conclude by mid-March, thereby ending the university's official ties to the practical component of this project (finishing the academic component consisting of write-up and report with further background research and investigation remained to be completed during the coming fall semester). This would allow for going public separate of APU. A new website was developed, www.anchorageavalanchecenter.org (see Appendix N, pg. 82), and the advisory program was made available to the general public.

Partnership with the North America Outdoor Institute (NAOI):

Another important partnership was formed at the time this project went public, between the AAC, AAIC, and NAOI. The nonprofit NAOI provides a host of outdoor safety programs throughout

Alaska, with numerous avalanche awareness and education offerings (primarily contracted through the state of Alaska's Department of Public Safety and snowmobile retailers), and was obliged to lend their support. They provided more reputable backing, publicity, and other means of supporting the project. They offered to involve the AAC in avalanche awareness and education outreach efforts and are providing AAIC avalanche centers with equipment donations from industry sponsors such as avalanche airbags, beacons, shovels, and probes to be used for field work and during educational outreach events.

Exploring alternative methods:

To conclude the methods section, it is worth mentioning that during the interim period between initial contact with the AAIC and going public as the AAC alternative project methods were explored – mainly in regard to the structure and format of the weekly avalanche advisory. This was spurred by discussion with Mr. Carter about further surveying the formats of avalanche centers in North America to better understand the many different approaches these centers employ in structuring an advisory.

Based on examination of the plethora of formats employed by avalanche centers in the United States and Canada, a three day forecast was trialed for a couple weeks in early March. This was the format Mr. Carter used for the VAC and was based on the methods of Canadian avalanche centers, which seem to be more unified in their approach and methods than US centers. It is worth mentioning that the Canadians also seem to have a more developed and sophisticated snow-avalanche industry than the US, in general.

The VAC method explored was an attempt to provide the public with more than just a weekly advisory, but still within the abilities of a grassroots model employing one full time staff. The three day forecast method made creating the advisory actual avalanche forecasting, not just nowcasting which is the norm. Nowcasting is based primarily on past and current conditions and the weather forecast for the day under consideration. Forecasting adds anticipated future conditions, primarily based on how forecast weather beyond the day at hand will affect current conditions, into the equation. The three day forecast was the source of much scrutiny from the CNFAIC and it was also discouraged by NAC director Karl Birkeland (personal communications, March 2013). They proposed that nowcasting is difficult enough, especially for an operation with limited staff and resources.

In addition to the three day forecast a danger trend section, discussing anticipated changes in conditions over the course of the three days for which the advisory was issued, was added to the advisory format. A travel advice section discussing snow-avalanche condition implications for route decisions was also added. These sections were sources of further scrutiny from the CNFAIC.

The three day forecast was scrapped before the project went public. However, at the time the project went public initial methods had been modified. Even without the three day forecast the new format was a source of scrutiny from the CNFAIC, mainly due to incorporation of ratings from the *North American Public Avalanche Danger Scale* into the advisories with associated colors and icons. The CNFAIC also had an issue with calling this project and the program that was made available to the public an avalanche center (more on this scrutiny in the discussion section on pages 47-48).

Discussion

This section is divided into two parts. First, challenges encountered throughout the project are presented and discussed. The second part, the conclusion of this report, looks at the future of this project; viability and sustainability are explored.

Part 1: Project Challenges

APU snow science faculty on sabbatical:

The first significant challenge encountered was APU snow science faculty, Ms. Latosuo, being on sabbatical during the academic year this project was conducted. She had a role in setting the stage for this project and assisting with initial planning and preparation. While Ms. Latosuo was initially committed to staying involved with this project during her sabbatical, as she stated it was important to her personally and professionally outside of her university responsibilities, circumstances left her with limited time to invest in this project while away from her university duties. The absence of her expertise and assistance was a loss.

The Chugach State Park dilemma:

As mentioned earlier, a first effort of this project was identifying and meeting with primary stakeholders to inform them of the project and ask for their support. Initial meetings revealed a host of challenges primarily of a more practical nature, albeit tinged by politics. Meetings with the CSP superintendent set the stage. Mr. Harrison wanted to make sure the public would not perceive CSP as being officially involved with this project. If the project went public it needed to be clear that it was an effort exclusive of CSP involvement (personal communication, spring 2012).

If it appeared that CSP was backing the project, this might stoke public expectations. Since this project's viability and sustainability was uncertain, stoking public expectations could result in demand for CSP to step up and provide for continuation of the avalanche advisory program if the consortium model envisioned failed to do so. With limited time, money, and resources, CSP couldn't risk having to deal with this demand. However, again worth mentioning, providing for a program such as that envisioned by this project is pennies compared to trail building and construction projects that CSP apparently has less difficulty tackling. As Mr. Harrison himself stated that avalanches are the most serious threats to park users (personal communication, Spring 2012), and Gellings' (2010) feasibility study provided justification as far as the public's desire for such as program, the need is obvious and likely as substantial as any other project in which CSP might invest in the near future.

The necessity of public demand:

A telephone conversation with Simon Trautman, director of the reputable USFS Sawtooth Avalanche Center (SAC) in Idaho, revealed that public demand is a primary prerequisite for a viable and sustainable avalanche center. He recapped the history of the SAC, explaining that in the early years the avalanche center effort for the Sawtooths involved wrestling with the Forest Service for viability. While (as most USFS avalanche centers) the SAC had a non-profit support group (F-SAC) similar to the F-CNFAIC, long term viability and sustainability was dependent on USFS investment. A challenge of the SAC and F-SAC in their early years was building public demand for substantial USFS investment. As members of communities such as Hailey, Ketchum, and Stanley were viewed as Sawtooth National Forest constituents, their demand for the USFS to help provide for the SAC was essential to this avalanche center building from the grassroots level (nearly two decades ago) to their current operations as one of the US' longstanding Type 2 avalanche centers.

Tragedy as the unfortunate catalyst for critical demand:

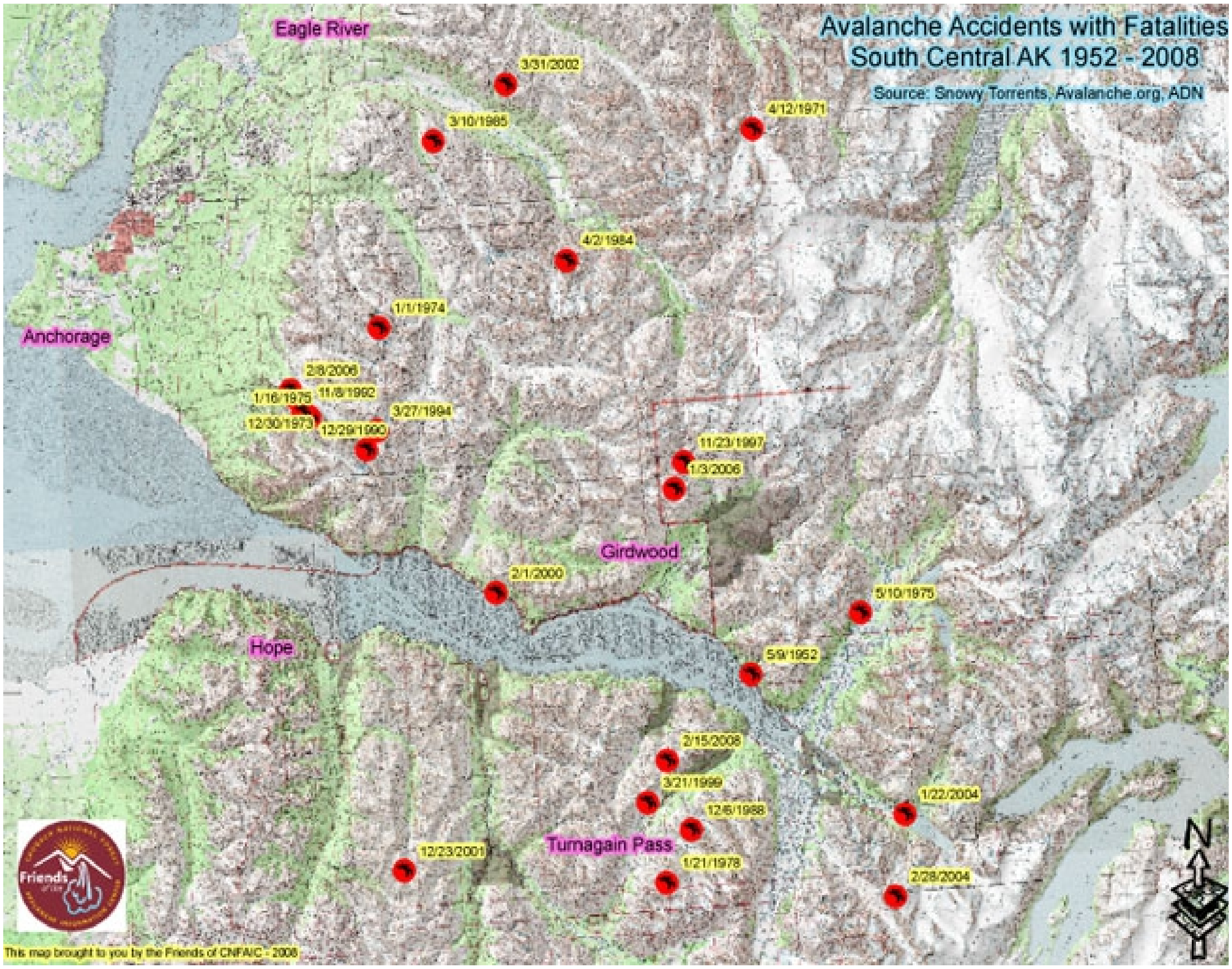
While some degree of public demand for the SAC existed from the start, Mr. Trautman explained that it was tragedy that created the critical demand necessary for the USFS to get on board. It is worth noting that tragedy, and resultant community demand, was also a primary catalyst for the creation of the CNFAIC. The take home point for this project is that, as CSP is a primary stakeholder and the land manager responsible for the avalanche terrain this project provides information for, CSP investment, at least as a primary stakeholder in the consortium, is likely necessary for long term sustainability and viability. As Gellings (2010) feasibility study posits, and as all the avalanche terrain under consideration by this project is in CSP, a more appropriate name for the AAC is actually the Chugach State Park Avalanche Information Center (CSPAIC).

However, as already discussed, the CSPAIC starting point was unrealistic and another approach, at least as an initial catalyst, was necessary. As there have already been numerous avalanche related casualties and fatalities in CSP, past tragedies have already occurred:

Chugach State Park Avalanche Accidents

Name	Date	Location	Activity	Fatalities
Patrick McDaniel	Dec-73	Flattop	Hiker	1
Cletus Kraft	1/16/1975	Flattop	Hiker	1
????	?/?/1976	Peak 3 area	Skiing	1
Stephen Campbell	Apr-84	Eagle Peak	Skiing	1
Fernin Koch	3/11/1985	South Fork Eagle River Valley	Skier	1
Curt Falldorf	12/30/1990	Powerline Pass	Snowmachiner	1
Bruce Hickok	11/9/1992	Peak 3	Skiing	1
Geoffrey Radford	11/9/1992	Peak 3	Skiing	1
Brandon Ford	3/27/1994	Powerline Pass	Snowmachiner	1
Troy Feller Bill Moxlow	3/21/1999	Powerline Pass	Snowmachiners	0
Nick Coltman	11/11/2000	Flattop	Hiker	0
Bill Crouse Don Zimmerman	3/31/2002	Mt. Magnificent	Hikers	2
Brian Mulvehill	2/8/2006	Flattop	Hiker	1
Brasher Schorr	2/13/2010	Highland Road "Three Bowls"	Skiing	1
				13

Obtained from:
http://www.alaska.net/~jlanders/Fatal/TableOfContents.htm
www.adn.com
www.avalanche.org
(Fig. 3)



(Fig. 4)

While tragedy, unfortunately, made for the critical demand necessary for the SAC's development, the situation for CSP is different. There hasn't been a prominent movement, to be fueled by public demand, for a CSP avalanche center in existence at the time of these tragedies. The hope is that the AAC's existence will prevent any such future tragedies, but this hope is not the reality as with an increasing number of users and activity in CSP avalanche terrain future tragedies are likely inevitable. As Mr. Trautman and other snow-avalanche professionals have explained, no matter how sophisticated, accurate, and reliable an avalanche advisory program, an avalanche center can not, absolutely, prevent tragedies.

Now that the AAC exists, but is still in a grassroots stage similar to the SAC before tragedy created the critical demand for its development into a viable and sustainable institution, a future tragedy may (again, unfortunately) be the necessary catalyst to boost public demand to a level that will require primary stakeholders like CSP to invest, in order that the AAC develop into a viable and sustainable entity capable of providing information for the long term. Thus, while CSP is wary of public demand being created by this project, demand from CSP constituents and resultant CSP investment is essential to the long term success of this effort.

Upon meeting with F-CNFAIC, they were well aware of the primary challenge poised by CSP: no government resources to support this project. The meeting with F-CNFAIC made clear the implications of this challenge: addressing the viability and sustainability of this project, at least initially, would have to be done without the input of resources from the primary land manager for whose avalanche terrain this project provides information. F-CNFAIC has long been interested in addressing the absence of organized avalanche information for the Front Range and Eagle River area Chugach; they've had establishing advisory programs for this area and the Hatcher Pass area as stated goals on their website. However, questions as to sustainability and liability remained unanswered and, unlike the AAIC, they were not willing to expedite a solution without concrete answers to these questions.

Enter the Alaska Avalanche Information Center (AAIC):

One of the AAIC's long term goals is creating an integrated network of statewide avalanche information through coordinated recreational avalanche advisories and the sharing of professional as well as public field observations, which is actually in part in response to an Alaskan state law that mandates the creation of such a network (more on this later, pg. 43). The AAIC, as already mentioned, is well aware of the absence of organized avalanche information for the Front Range and Eagle River area Chugach. However, the AAIC differs from the F-CNFAIC in their approach to addressing this issue in its willingness to expedite a solution (although this expediency has been a source of scrutiny). Hence, the AAIC offering their full support for this project to go public without fully addressing sustainability concerns. On the other hand, the liability question was one for which the AAIC had an immediate and concrete answer.

As a 501(c)3 non-profit set up as an umbrella organization providing for several non-government avalanche centers throughout Alaska, the AAIC has private liability insurance coverage for the operations of its satellite avalanche centers. Before getting connected with this project, the AAIC had most recently partnered with Jed Workman and Allie Barker to create the Hatcher Pass Avalanche Center, cover their liability needs, and provide non-profit status for fundraising. Thus, a solution to the absence of organized avalanche information for the popular avalanche terrain of the Hatcher Pass area was provided by liability insurance coverage and nonprofit status through the AAIC and assistance with fundraising and meeting the operational budget through the F-CNFAIC. While the AAIC and F-CNFAIC were both making the HPAC effort possible, this wasn't a coordinated effort between the two organizations who have often, unfortunately, been in opposition to one another due to political disagreements.

Land management implications for Alaska's avalanche terrain:

Alaska's vast public lands, managed by a host of different municipal, state, and federal government agencies, make for a unique situation in regard to providing backcountry avalanche information. In the contiguous 48 states, perhaps the majority of all avalanche terrain and definitely the avalanche terrain where most accidents occur is on public land managed by the USFS. This includes the avalanche terrain of most US ski resorts (with longstanding avalanche mitigation programs required for their operations), which is on land leased by the USFS.

Thus, the USFS has a long history of involvement with avalanche terrain, due to the nature of the land it manages. Hence, the USFS, through the NAC, has been the primary force behind the development of protocols for the operations of backcountry avalanche programs in the US. In addition, avalanche programs developed for USFS managed land are supported by and able to lean on existing USFS infrastructure, resources, and staffing – including budgetary funding, buildings, communications technology, vehicles, equipment, and the diverse staff expertise of USFS ranger districts in the vicinity of avalanche terrain.

While the figures aren't available, in Alaska, on the other hand, the majority of avalanche terrain popular with recreationists may very well be on non-USFS managed land. For example, extensive acreage of avalanche terrain that is very popular with wintertime recreationists in Southcentral Alaska is managed by Alaska State Parks (ASP), such as that under consideration by this project and in the Hatcher Pass area of the Talkeetna Mountains for which the HPAC provides information. Vast swaths of avalanche terrain in the Alaska range are managed by the National Park Service (NPS) and Bureau of Land Management (BLM).

As the NPS and BLM seem to have considerably less avalanche terrain under their jurisdiction outside of Alaska, and similar agencies to ASP in the contiguous US only manage small areas of avalanche terrain, these agencies generally lack the protocol and experience necessary for providing recreational avalanche advisory programs. While there is considerable NPS avalanche terrain in the contiguous 48 states, such as that in the Cascades, Rockies, and Sierras, most of this NPS avalanche terrain is in close proximity to USFS avalanche centers or, at least, avalanche centers closely associated with the NAC. For example, the Bridger-Teton Avalanche Center, Northwest Avalanche Center, and Colorado Avalanche Information Center (USFS avalanche centers or closely associated with the USFS) partner (to varying degrees) with the NPS to provide avalanche information for NPS avalanche terrain in their vicinities.

For much of Alaska's non-USFS avalanche terrain (and even much of its USFS avalanche terrain), the need for backcountry avalanche information isn't dire due to remoteness, lack of accessibility, and little recreational traffic. However, for the ASP avalanche terrain in Southcentral Alaska, there has long been an identified need and the demand for such programs is increasing. As Gellings' (2010) study found, there's overwhelming support for a program to serve Chugach State Park.

This demand has likely increased exponentially, as since Gellings' study exposure of backcountry opportunities in the area has increased dramatically through publicity in ski films and guidebooks. There has been a remarkable increase in traffic to areas that are in avalanche terrain under consideration by this project since being identified in a winter backcountry skiing guidebook for Southcentral Alaska (Joe Stock's *The Alaska Factor*). Both human powered and motorized winter sports are growing rapidly in popularity.

Only one well-funded avalanche center in the state:

As mentioned earlier, there's only one well-funded (backcountry) avalanche center in the state, the CNFAIC, which serves USFS managed land south of Anchorage including eastern Turnagain Arm, Turnagain Pass, and the Summit Lake area. While the Chugach National Forest (CNF) covers 5.4 million acres and stretches from west of Hope to east of Cordova, only that extremely small fraction of the Forest south of Anchorage is provided with avalanche information. This is somewhat understandable, considering this avalanche terrain has long been popular with winter backcountry recreationists in the state's most heavily populated region, there's less of a demand for such a program serving the farther reaches and more isolated areas of the CNF, and a high profile accident in avalanche terrain now covered by the CNFAIC catalyzed the CNF and its constituents to create the CNFAIC. According to the CNFAIC website: “The roots for the Chugach Avalanche Center [sic] (CNFAIC) arose from the tragedy that occurred on March 21, 1999 at Turnagain Pass where 6 [sic] snow machiners [sic] were killed in a massive avalanche.”

AAIC and Alaskan law:

While the F-CNFAIC has long been interested in addressing the lack of avalanche information for other areas in Southcentral Alaska popular with recreationists, such as that under consideration by this project and in the Hatcher Pass area, they haven't been able to provide any viable solutions. Considering this and all the other avalanche terrain in the state not being addressed by the USFS, the AAIC comes into play. Alaska State Statute 18.76.010 states:

> The Department of Public Safety, acting in cooperation with a municipality or with an agency of the federal government, shall participate in the development and implementation of a statewide avalanche warning system and shall represent the state in the operation of that system. The statewide system shall:
>
> (1) establish and maintain a service center and primary and supplementary field stations to gather information and data concerning ground weather conditions, snow pack, and avalanche activity;
>
> (2) forecast snow avalanche conditions throughout the state;
>
> (3) coordinate a public awareness program on avalanche danger;
>
> (4) catalog a comprehensive atlas of avalanche paths and slide occurrences; and
>
> (5) assist local governments and state agencies in identifying hazardous avalanche zones and in developing snow avalanche zoning regulations.

Since the state has not taken steps to implement this statute and hasn't even been able to provide Alaska State Parks with a means of providing avalanche information for popular winter recreation areas, the AAIC was created in part to address this need. Part of the AAIC mission is "to reduce the number of avalanche-related accidents by increasing public awareness of the current local avalanche conditions in areas where a government public avalanche forecasting center is unavailable" (AAIC website – www.alaskasnow.org). While the AAIC currently operates as a small umbrella nonprofit providing the bare necessities for the operations of several satellite avalanche centers throughout the state, the long term goal is an integrated network of statewide avalanche information that could be similar to what is provided by the Northwest Avalanche Center (NWAC) of Washington and Oregon, the Utah Avalanche Center (UAC), or the Colorado Avalanche Information Center (CAIC). However, the aforementioned centers are currently receiving or have received in the past extensive government support, especially from the USFS and NAC.

USFS avalanche center structure:

Before further discussion of the AAIC is provided, it's necessary to provide a rudimentary understanding of how USFS centers function, in regard to the interesting interface between their nonprofit Friends groups and the federal government that makes these centers possible and provides for their operations. As mentioned, USFS avalanche centers rely heavily on federal government infrastructure, staffing, resources, and funding. However, this typically provides for only about 50% of their needs.

This is why USFS avalanche centers have nonprofit Friends groups, which provide for the rest of their needs. Whether it's the Sawtooth Avalanche Center, Utah Avalanche Center, or the Chugach National Forest Avalanche Information Center, their respective nonprofit Friends groups have a board of directors that negotiate a contract with the USFS for these avalanche centers operations, broker appropriated funds, and fundraise for the additional needs not provided by the USFS. For example, the CNFAIC is ~$150,000/season (six months from November-April) operation with about half of the resources coming from the USFS and the other half being fundraised by the F-CNFAIC (sourced from CNFAIC website and 2012-13 annual report). More information on United States avalanche centers' funding and structure can be found in Appendix O (pg. 83).

AAIC structure and struggle:

While the AAIC has operating standards and bylaw documents in place, they aren't widely regarded as alternatives to the NAC business plan and guidelines (likely due to most avalanche centers in the US being USFS or USFS-associated and thus not in need of a grassroots alternative). However, this is the only operational alternative for providing backcountry avalanche information for Alaska's vast avalanche terrain outside of that very small fraction of the CNF provided for by the CNFAIC. In fact, two AAIC centers, the Valdez Avalanche Center (VAC) and Cordova Avalanche Center (CAC), actually provide backcountry avalanche information for USFS land. However, they aren't actively being aided in their efforts by the NAC or the CNFAIC. This is in part because the CNF is so large and considering CNFAIC operational limitations, they choose to stay focused on the eastern Turnagain Arm and Turnagain Pass area. More recently they have put more resources towards providing information for avalanche terrain further south on the Kenai Peninsula in the Summit Lake area, which is in the vicinity of their office at the Glacier Ranger District station.

Thus, the struggle of avalanche centers in the state (besides the CNFAIC) has been developing the funding and protocols necessary for being sustainable in their efforts. The AAIC and it's five satellite avalanche centers (Anchorage, Hatcher Pass, Cordova, Valdez, Haines) are very minimalist and grassroots. As mentioned, the umbrella AAIC provides these five centers with liability insurance coverage and nonprofit status. However, since there's no centralized and well funded government agency to lean on and all individuals involved with the AAIC and its satellite centers do this recreational avalanche information work pro bono; time and energy is limited. Because of these limitations, AAIC avalanche centers have a very different operational capacity when compared to USFS avalanche centers that are supported, in part, by the federal government and have decades of collective history and associated experience in avalanche programming. AAIC centers' avalanche advisory products are, therefore, different than those provided by well-funded and staffed USFS avalanche centers.

Unfair scrutiny of AAIC efforts:

Differences in operational capacity and associated differences in the quality of avalanche awareness products has been a source of heavy handed scrutiny of the AAIC, primarily by the CNFAIC. While relatively well paid USFS avalanche professionals take their work very seriously and are truly dedicated to providing the public with the best possible avalanche information that is timely, accurate, and reliable, they are in a much different situation than unpaid AAIC avalanche professionals who work pro bono and without government infrastructure, resources, and support. It often seems that AAIC products are criticized because they don't measure up to that of well-funded USFS centers, but this is an unrealistic expectation considering the differences in circumstance.

This overview of some of the differences between USFS and AAIC avalanche centers is intended to serve as an introduction to the two primary players involved in providing backcountry avalanche information for Alaska. It is also meant to provide a basic understanding of their different operational capacities, how this has created controversy between the two parties, and thus created an oppositional political landscape.

Alaskan avalanche politics – CNFAIC & AAIC differences:

While there has been longstanding tension between the AAIC and CNFAIC, of which there's very limited rational understanding, one possible source of conflict between the CNFAIC and AAIC, especially as it pertains to this project, may be in regard to the AAIC's willingness to expedite solutions to a lack of avalanche information. As mentioned, the F-CNFAIC has long been interested in addressing the lack of organized avalanche information for the Anchorage area. However, they've not been able to answer questions of liability and long term sustainability which they view as prerequisites for implementing some sort of solution.

As the F-CNFAIC is associated with the USFS, they're beholden to the NAC business plan and guidelines. As providing for a Front Range and Eagle River area avalanche information program would be burdensome for the F-CNFAIC (especially to stay in accordance with NAC guidelines), they've chosen to allocate almost all resources to the CNFAIC in order that it provide the best information possible for its advisory area, even though it's only a very small portion of Southcentral Alaska avalanche terrain that is popular with recreationists.

On the other hand, the AAIC, being a grassroots operation, has less constraints in regard to taking immediate action. The AAIC can seemingly start a new avalanche center simply by paying for additional liability insurance coverage and having a qualified individual willing to provide information. While the F-CNFAIC's approach is to have funding in place and sustainability addressed before it will take any action, the AAIC is very different. It will implement programs without having all the details of funding and sustainability lined up as this is the nature of a grassroots effort; if everything has to be in place beforehand (and assuredly sustainable at that) efforts such as the AAC and HPAC would likely never take off (and this may be why they never did before getting connected with the AAIC).

The AAIC, as a completely volunteer effort with no government agency to lean on, provides for the vast majority of Alaska's avalanche information – much more than the CNFAIC, whose staff is relatively well paid and whose operations are supported by extensive USFS and federal government infrastructure and resources. Although, admittedly, the nature and quality of AAIC and CNFAIC products are different.

AAIC opposition to the NAC model:

The heart of AAIC opposition to the NAC model centers around the seeming inapplicability of the NAC model, at least without considerable modification, to Alaska's non-USFS avalanche terrain. The land managers in charge of non-USFS avalanche terrain lack the necessary protocol and experience for providing recreational avalanche information, and for non-government avalanche centers there's no existing infrastructure to lean on. This makes adhering to the NAC model for development more difficult than for USFS centers that aren't starting as much from scratch. Adding to this, not only are AAIC centers operated by volunteers, but all besides the AAC serve rural or more isolated communities for which developing a Friends type organization to interface with a government land management agency would be much more difficult, logistically challenging, and time consuming.

Thus, the AAIC grassroots centers do their best to provide some avalanche information as opposed to none. The AAIC views this as preferable to doing nothing until everything is in place for a sustainably funded avalanche center with paid Avalanche Specialist positions, which may never be feasible for much of Alaska's avalanche terrain. The AAIC also doesn't feel the need to comply with the NAC model and guidelines as they're not working with exclusively USFS managed land and aren't receiving any aid or support from the USFS or NAC.

Referring to an avalanche information program as an avalanche center:

Another source of conflict between the AAIC and CNFAIC is in regard to naming. That is, calling an avalanche information program an *avalanche center*. The CNFAIC is worried that by calling AAIC advisory programs avalanche centers the public will be confused as to what constitutes an avalanche center. For example, the operational capacity of the Anchorage Avalanche Center and CNFAIC is very different; a new program with volunteer staff of one and no government infrastructure versus a well funded program that has been existence for over a decade with a well paid staff of four and the infrastructure of the federal government.

However, it should be noted that AAIC avalanche center websites all clearly state that they are volunteer and grassroots efforts; they do not try to equate themselves to well-funded, infrastructure intensive government avalanche centers. Additionally, this criticism and scrutiny, originating from and being spread by the CNFAIC is characterized by inconsistencies and double standards. For instance, in regard to naming, even the two Type 4 centers in the US that are officially endorsed and sanctioned by both the NAC and American Avalanche Association (AAA) and operate according to the NAC guidelines call themselves *avalanche centers* (Kachina Peaks Avalanche Center and Wallowa Avalanche Center).

Controversy in regard to providing advisories with danger ratings:

Further conflict centers around the use of the *North American Public Avalanche Danger Scale* in the advisories provided by AAIC centers, which include a danger rating (low, moderate, considerable, high or extreme – see Appendix I, pg. 68). According to the NAC model, avalanche centers should start at the Type 4 level and operate at this level until the sustainable funding and resources are available for developing into a Type 3 center. As Type 4 centers are't even supposed to provide advisories, they definitely aren't supposed to provide advisories with a danger rating – at least according to the USFS NAC. However, the USFS doesn't have ownership or copyright of the danger scale; it was developed cooperatively by snow-avalanche professionals and organizations from throughout the US and Canada as a tool to easily and effectively convey avalanche conditions to the general public.

In regard to the conflict between the CNFAIC and AAIC, at least the critique in regard to AAIC centers providing advisories with danger ratings has some (albeit limited) substance. The CNFAIC pressured the AAC to not use the danger scale or provide danger ratings with associated colors and icons when it went public. The CNFAIC argued that AAC staff wasn't qualified to issue an advisory with a danger rating and danger ratings weren't appropriate for the AAC's level of development.

However, AAC staff arguably meet the qualifications for Avalanche Specialist, and definitely meet the qualifications for Avalanche Coordinator, as outlined in the NAC business plan and operational guidelines. AAC staff are also arguably more qualified than former CNFAIC staff that have issued advisories with danger ratings. Eliminating the danger ratings from advisories was not a method the AAC was interested in changing during the 2012-13 season when it had the equivalent of one full time staff, thus providing it with the operational capacity characteristic of a Type 3 center for which, according to the NAC guidelines, it is appropriate to issue an advisory with danger rating.

The CNFAIC suggested only a discussion of what the danger rating meant, without providing the actual rating and explanatory icon that was developed to provide a quick an easy to digest description of associated avalanche conditions. This seemed illogical and the AAC persisted in using danger ratings and associated icons as these were developed to be effective communication tools. After all, that's what the danger scale was developed for: communicating avalanche conditions quickly, effectively, and in a way the public could easily digest. To the AAIC, this method of not providing a danger rating, but instead relying on more cumbersome text than would be necessary if a danger rating was used, results in an "incomprehensible wall of print" (Mr. Carter, personal communications, multiple occasions). In this regard, including a danger rating in an advisory lends the advisory tone and structure that would be absent without it. Without the added tone and structure a danger rating provides, an advisory is more susceptible to becoming an "incomprehensible wall of print."

The challenges of working with undergraduate students:

Soon after this project officially began in the Spring semester of 2013, work with the APU undergraduate commenced. However, it quickly became apparent that, despite initial screening, this student lacked basic avalanche knowledge that should have been attained through successfully completing prior APU snow science courses. According to the university catalog and syllabi for the prerequisite courses for getting involved with this project, prospective undergraduates should have already developed at least intermediate avalanche skills characteristic of those having completed Level 1 and 2 avalanche trainings outside APU. Skills gained from these trainings include proficiency, or at least familiarity, with snowpits and the recording of snowpit profiles and stability test results to the national standards put forth in *SWAG* – in addition to the standards for documenting snow, weather, and avalanche observations.

Because this undergraduate lacked these skills, rather than her being able to assist with field work in a way that contributed to the advisory program's development, working with her became another project entirely: helping her to develop skills that it was thought she already possessed from prior APU courses. She knew how to dig a snowpit, but didn't know how to analyze it or take any useful data from it. She was also relatively clueless about the *SWAG* documentation standards. In the end, field work with this undergraduate student was limited due to her level of preparedness and engagement.

The take home point is that there's much more to working with undergraduates, especially in the field, than may be initially expected by an instructor without much prior experience in this regard. The motivation and competencies of students at this level varies greatly and this has to be taken into account. While the experience of working with an undergraduate through this project created unforeseen challenges, it was insightful for future work with volunteers, interns, and students as these may be likely resources for the AAC effort as it develops at the grassroots level.

Future work with volunteers, students, and interns:

While the AAC, as a grassroots and volunteer effort, will need all the assistance it can get from public observers, volunteers, students, and interns, working with these individuals (that will likely bring a spectrum of skills and experience to the table) will require coordination and management to make the most of their assistance. Any and all observations from the general public and those recreating in the avalanche terrain under consideration by this project are encouraged and there's no prerequisites for providing this sort of assistance to the AAC. However, other volunteer, student, and intern capacities will have to be assessed and coordinated according to individual qualifications.

Initially, and perhaps until the AAC is able to acquire the funding for one paid full time Avalanche Specialist that is able to focus on the AAC effort without other employment distractions and serious commitments during the snow season, trying to extensively coordinate volunteers, students and interns may be too cumbersome to be worthwhile. For example, all of the volunteers that worked with the project designer on independent field days during the 2012-13 season were strong, fit skiers with advanced avalanche knowledge and backcountry experience. This was necessary for getting the most out of field days and in order to cover a lot of ground, travel safely through complex terrain, acquire pertinent field data for producing the advisory, and effectively survey the conditions of a dynamic and highly variable snowpack.

In order to get the most out of limited time in the field (limited time in general for a pro bono effort), there isn't room for dealing with volunteer, student, or intern situations similar to what happened with the undergraduate student that was involved with the first season of this project. Dealing with such situations, until more time and resources can be sustainably dedicated to the AAC effort, detracts from the necessary focus of acquiring sufficient field data and providing an accurate, reliable advisory program. Thus, if volunteers, students, and interns seek to get involved with the AAC effort in the near future, they will largely have to be self-sufficient. In order to accompany AAC staff during the limited time available for field work, they will have to be fit, strong skiers capable of keeping up and making their own observational contributions. Otherwise, these individuals will need a plan in order that they work independently to contribute to the AAC effort.

The hope is that the AAC will grow and develop in the upcoming seasons and eventually be able to provide for one full time Avalanche Specialist dedicated and committed to the AAC for six months out of the year. Sustainably providing for this grassroots and minimalist model with one full time paid Avalanche Specialist will allow that individual to start working to build other capacities for developing the AAC's field work and programming besides his/her own. Examples of what this might entail include structured internships and experiential learning opportunities for students (as providing such opportunities to APU OS snow science students was an initial project impetus and goal), providing structured observer trainings to teach public volunteers how to most effectively contribute field data through their own observations, and offering avalanche awareness clinics and field days to the public in order that the least knowledgable recreationists develop their winter backcountry skills in order to keep themselves safe and in hopes that they contribute their observations (no matter how basic) to the AAC.

Field work challenges:

Overall, the field work strategy was effective and successful so as to produce a timely, accurate, and reliable weekly to semi-weekly avalanche advisory for the 2012-13 season within the constraints of the minimalist, grassroots model. However, as can be inferred from what has already been mentioned and discussed in previous pages, there are numerous constraints and limitations to the grassroots, minimalist approach. While each of the four core advisory areas were able to be visited regularly and, in a rudimentary way, conditions surveyed effectively enough to provide for the advisory program offered during the 2012-13 season, acquiring more time, resources, and manpower will provide for increasingly well developed, accurate, reliable, sophisticated and timely avalanche information products.

As mentioned in the methods section on field work strategy, the approach during the 2012-13 season (fitting with the minimalist model) emphasized quick stability assessment on the move in order to cover a lot of ground and sufficiently survey conditions across a lot of terrain. More time and manpower would allow for more in-depth snow science (snow study plots, digging full pit profiles to track layers and snow metamorphism over the course of a season, more thoroughly assessing the snowpack and spatial variability from one advisory area to the next and at different elevation bands, etc.) to increase the professionalism of the AAC product and enhance the advisory program's reliability and accuracy. However, as well-funded USFS avalanche centers often seem to have difficulty committing to in-depth, advanced snow science tasks in a structured way, it is a long term goal for the AAC. Additionally, as more time and manpower is acquired for the AAC effort, how to appropriate these resources will be a serious consideration. Should initial acquisitions of more time and energy be allocated to developing volunteer, student, and intern assets, to more in-depth and advanced snow science, or to a combination of such options?

The trials and tribulations of becoming an Avalanche Specialist:

The author's route to becoming an Avalanche Specialist has been untraditional. Because he was not already an established professional in the snow-avalanche industry at the time he launched this project, he faced considerably more challenges than he would otherwise. He has been criticized as unqualified to produce avalanche advisories, especially with danger ratings, by CNFAIC staff that know little of his experience or skills. However, as mentioned earlier, he is arguably more qualified than former CNFAIC staff that have issued advisories with danger ratings and meets NAC guidelines pertaining to the qualifications of Avalanche Specialists and Coordinators.

In addition to the insights provided throughout this report, there are other necessary components for being an effective and successful Avalanche Specialist that may be inferred but have't yet been identified. That is, pointing out that there's much more involved than the technical skills required for the mandatory backcountry travel and snow science field work. A certain degree of character is necessary; one that includes professionalism, positivity, and perhaps most importantly perseverance. A good sense of humor, in order to put the nature of this work into perspective (it's just recreation), is also a necessity – especially when faced, as in the case of this project, with the pretentiousness of other snow-avalanche professionals who offer little to no support but plenty of heavy-handed scrutiny.

All of this is especially true for an Avalanche Specialist that is not already established in the industry and is attempting to start and develop a grassroots program. As important as collecting the pertinent field data, providing professional quality observations, and integrating all available information into a well-written and easily digestible avalanche advisory, are the community building and public relations skills that are essential to any successful grassroots effort. Add to this the need for that unestablished Avalanche Specialist to work even harder to prove him or herself, as in this case.

Through the experience of this project, the most challenging aspect has been identified: navigating politics and personalities. In fact, as the author has a BA in Psychology, he feels as if he's learned more about psychology through this MSOEE thesis project than he did through his psychology specific undergraduate Senior Project. As mentioned earlier in regard to the scrutiny of this project, primarily by the CNFAIC, critique of his efforts on this project have often been characterized by inconsistencies and double standards – thus creating further difficulties and challenges in the realm of politics and personalities rather than substantive and concrete critique.

How does one address the nature of such challenges and difficulties? Hence the emphasis on the necessity of an effective Avalanche Specialist, especially in the grassroots domain, possessing strong community building and public relations skills. Not to mention, in order to stay sane, a good sense of humor and ability to put a recreational effort such as this into perspective so as to undermine unreasonable lambasting by detractors.

Part 2: Viability & Sustainability:

Outline for the future:

As described earlier, during the 2012-13 season the avalanche advisory program conducted as part of this project functioned characteristic of the guidelines for a NAC Type 3 avalanche center. Continuing to provide the same quality of information at regular intervals as was done during the 2012-

13 season has been deemed, through the experience of undertaking this project, to require at least one full time staff. As tested during the 2012-13 season, in order to assess the viability of this minimalist approach, the primary expense would be the salary for one full time staff who would meet other expenses for the advisory program's operations, at least initially, out of pocket via his/her salary.

In line with industry-standard wages for an entry-level Avalanche Specialist working full time for the six month season through which most avalanche centers operate, it would cost ~$20,000/season for the AAC to provide the same product it offered during the spring of 2013 indefinitely. This includes professional quality observations two to three times per week, at least a weekly avalanche advisory, and management of a website and forum for public submission of field observations. While ~$20,000/season would provide for the minimalist model, basically just paying the salary for one full time staff, additional expenses would be required for the center to develop into a more viable entity.

An AAC budget for long term sustainability can be found in the appendices (Appendix J, pg. 69), which provides further details. This budget is in line with what is suggested for a Type 3 center as outlined in the NAC business plan and operational guidelines. ~$30,000/season would provide the AAC with one full time staff, transportation expenses, one significant professional development opportunity per season, gear for field work, communications technology, and a small budget to offer incentives for volunteers.

Initially, funds towards reaching the goal of continuing to provide for a minimalist avalanche advisory program could be provided by donations to the AAC from individuals, local businesses and organizations, identified stakeholders, and industry sponsors. These donations would be tax deductible via the AAC's 501(c)3 status provided by its partnership with the Alaska Avalanche Information Center. Another approach may be for the land manager, Chugach State Park, to contract the AAC to provide the advisory program for its avalanche terrain. This contract could include part of, all of, or more than what is needed for the ~$20,000/season minimalist model. The AAC could then continue to raise additional funds via donations, which would allow the program to develop into a solid Type 3 center with a budget of ~$30,000/season.

The relationship between CSP and the AAC could function similar to the NAC model for avalanche centers in which a contract is made between the government entity and a nonprofit group to implement the program. In the case of this project, the scenario could be for CSP to contract the Alaska Avalanche Information Center to provide for a Chugach State Park Avalanche Information Center (CSPAIC). This framework would provide for the most appropriate way to convey this program to the public; all the avalanche terrain under consideration by this project is in CSP and providing for such a program seems within reasonable expectations, and to be the responsibility, of the land manager.

After the budget for a sustainable Type 3 center is met, the program could focus on developing into a Type 2 center with additional staff, infrastructure, and resources. With more staff and a bigger budget the AAC could expand its core advisory area and provide avalanche information for more of Chugach State Park, which would also likely make the program increasingly popular with the motorized (snowmobile) community as CSP avalanche terrain outside of the current core advisory area is more regularly open to motorized use. Eventually, if funds were available or an agreement with CSP was reached to provide for a truck, trailer, and snowmobile, operations could expand to include areas of CSP such as Northern Turnagain Arm and Eklutna Lake, which are more popular with motorized recreationists than the current advisory area.

Making the minimalist model work in the meantime:

While the ~$20,000/season budget for the AAC to continue providing the products it did during the 2012-13 season may not be immediately available, the AAC is committed to continuing to provide some sort of organized avalanche information for the Front Range and Eagle River area Chugach in the interim. As the time constraints of a 100% volunteer effort in which all individuals involved have other priorities in order to meet the expenses of day to day life, this may simply be continuing to manage a forum for the submission of public observations and providing professional quality observations as often as possible.

As the details for how the AAC will function in the short term come together, there will be a continued need for volunteer assistance. Such needs to keep the center functioning at a very grassroots level will be able to met by recreationists submitting their field observations as often as possible, local snow-avalanche professionals and snow-avalanche organizations providing whatever assistance they can, and more involvement from the APU Outdoor Studies snow science program. Local snow-avalanche organizations including those identified as primary stakeholders have a lot to offer when it comes to the community outreach necessary for letting people know about this project in order to raise funds and increase the submission of observations that make a reliable and accurate advisory program possible.

These organizations also have a lot to gain from the AAC effort as well. As the goal of Alaska Avalanche School education "is to increase backcountry users awareness and reduce exposure to avalanche conditions" (found on AAS website homepage), AAC efforts are a huge step towards AAS' goal. Likewise for the F-CNFAIC's longstanding goal of establishing an advisory program for Chugach State Park. As an initial intention of this project was to provide further snow science opportunities for the APU OS curriculum, specifically an experiential learning laboratory exclusive to APU, the AAC has a lot to offer in exchange for student volunteers and interns to help bolster field work. Finally, local businesses and industry sponsors will be able to show the community their investment in public safety and healthy wintertime recreation opportunities by supporting the AAC and having their contributions publicized via the AAC website.

Needs for reaching a solid, sustainable Type 3 level of operations:

Building on what will be necessary for successful operations at a grassroots level, continually increasing investment from stakeholders, community businesses and organizations, corporate and industry sponsors, and individual users will make it possible for the AAC to reach the minimalist budget required for sustaining operations characteristic of the 2012-13 season. A contract with CSP or appropriation from the state of Alaska, donations from local businesses, further investment from industry and corporate sponsors, increasing individual and user donations, and cooperative fundraising with stakeholders such as the CNFAIC and AAS will make the sustainable Type 3 goal possible.

Conclusion

Coming back to the framing question for this thesis project (What's involved in starting and developing a backcountry avalanche advisory program and in becoming an Avalanche Specialist?) is an appropriate conclusion. Hopefully a good deal of insight into this question has been provided throughout this report. Suffice to say that A LOT is involved in starting an avalanche advisory program; much more is required to develop it into something viable and sustainable. While Avalanche Specialists range from ski patrollers to PhD scientists, years of experience working and recreating in avalanche terrain and seeking specialized learning opportunities is prerequisite. Both becoming an Avalanche Specialist and starting an advisory program require commitment, dedication, extreme perseverance, attention to detail, creativity, positivity, and patience in the slow process of building credentials and qualifications or developing a program from startup to viability and sustainability.

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Appendices

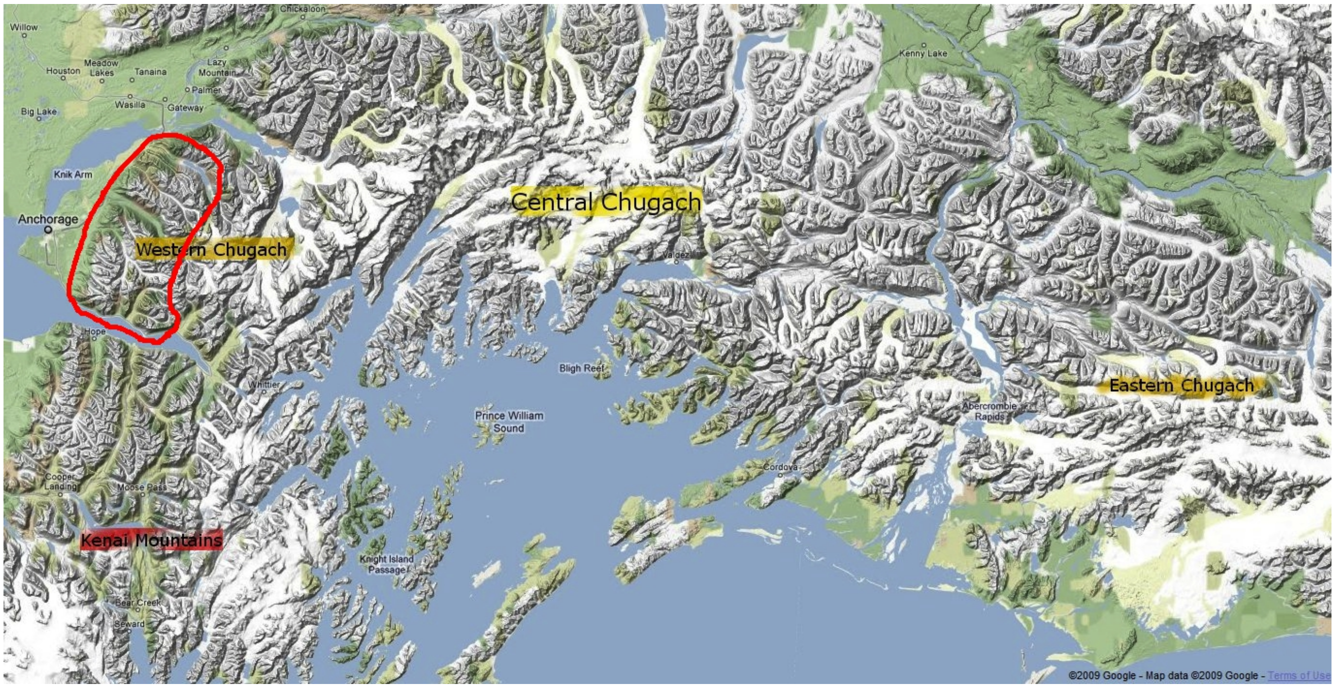
Appendix A – Map of North America's avalanche centers:

Only shows avalanche centers currently recognized by the American Avalanche Association and USFS National Avalanche Center. Only shows headquarters of Canadian Avalanche Centre, Association, and Foundation (doesn't show the numerous local offices of Canadian Avalanche Centre). Image from *Powder Magazine*.

Appendix B – Map of Alaska's Mountains:

Appendix C – Map of Chugach Mountains:

Chugach State Park outlined in red (approximate)

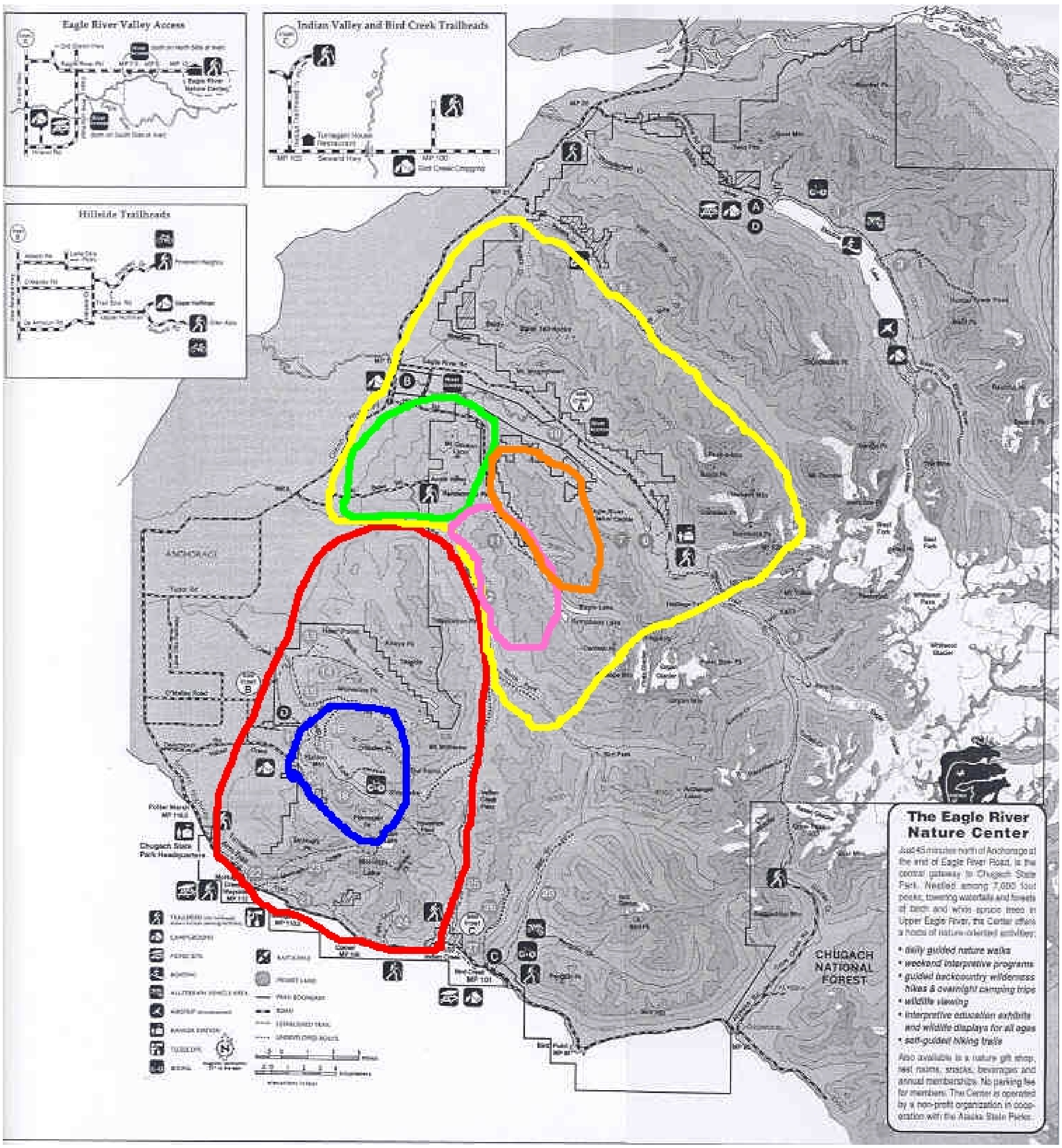


Appendix D – Map of Chugach State Park:

Front Range: in red

Eagle River area: in yellow

Core advisory area: Canyon Road and Glen Alps access in blue, South Fork access in pink, Hiland Road access in orange, Arctic Valley access in green



Appendix E – Core advisory area for the 2012-13 season (outlined in red):

Northern: Arctic Valley access, South Fork access, Hiland Road access

Southern: Glen Alps access, Canyon Road access

Appendix F – Arctic Valley access avalanche terrain:

Appendix G – South Fork access (top) and Hiland Road access (bottom) avalanche terrain:

Appendix H – Glen Alps access (top) and Canyon Road access (bottom) avalanche terrain:

Appendix I – North American Public Avalanche Danger Scale:

North American Public Avalanche Danger Scale

Avalanche danger is determined by the likelihood, size and distribution of avalanches.

Danger Level	Travel Advice	Likelihood of Avalanches	Avalanche Size and Distribution
5 Extreme	Avoid all avalanche terrain.	Natural and human-triggered avalanches certain.	Large to very large avalanches in many areas.
4 High	Very dangerous avalanche conditions. Travel in avalanche terrain not recommended.	Natural avalanches likely; human-triggered avalanches very likely.	Large avalanches in many areas; or very large avalanches in specific areas.
3 Considerable	Dangerous avalanche conditions. Careful snowpack evaluation, cautious route-finding and conservative decision-making essential.	Natural avalanches possible; human-triggered avalanches likely.	Small avalanches in many areas; or large avalanches in specific areas; or very large avalanches in isolated areas.
2 Moderate	Heightened avalanche conditions on specific terrain features. Evaluate snow and terrain carefully; identify features of concern.	Natural avalanches unlikely; human-triggered avalanches possible.	Small avalanches in specific areas; or large avalanches in isolated areas.
1 Low	Generally safe avalanche conditions. Watch for unstable snow on isolated terrain features.	Natural and human-triggered avalanches unlikely.	Small avalanches in isolated areas or extreme terrain.

Safe backcountry travel requires training and experience. You control your own risk by choosing where, when and how you travel.

Appendix J – AAC budget for long-term sustainability:

Anchorage Avalanche Center (AAC)
2013-14 Seasonal Operating Budget for Long-Term Sustainability

Staff wage: $21,000

Based on having one six month seasonal full time director-avalanche specialist or one ¾ time director-avalanche specialist and one ¼ time avalanche specialist at a wage of $20/hr. This is at the low end of the market wage for this sort of position; the current rate of entry level avalanche specialists at the Colorado Avalanche Information Center (CAIC).

Transportation expenses: $1500 ($5000)

Based on four field days a week with ~30 miles of driving each day at mileage reimbursement of $.50/mile. Additionally, a nominal amount has been included for routine vehicle maintenance for the six month season. In parentheses is an additional amount for a used 4WD vehicle for the center (currently the avalanche specialists drive their personal vehicles for field days).

Professional development: $2500

Based on one significant training or professional development event each season for one avalanche specialist. For the 2013-14 season the need is for a Level 3 course for the director-avalanche specialist, which may require travel expenses. In upcoming seasons the need will be for a CAA Level 2 and annual conferences/workshops such as ISSW.

Gear, equipment, & technology: $3000

Based on the need for one alpine ski touring setup and one set of field work attire at a 45% off pro-deal rate. Additionally, some seasons safety and rescue technology (beacons, shovels, probes, airbags) will need to be updated. Also includes $1000 for technology expenses such as high speed internet, website hosting, digital camera/camcorder, and other media-technology needs.

Observer incentives & events: $2000

Based on the need to offer incentives for high quality field observations from the public, to host special events, and offer basic avalanche and winter backcountry travel education opportunities to the public.

Total: $30,000

Appendix K - Directed study course syllabus:

OS 38000 DS: Field Work in Snow Science, 1-4 credits

Spring Semester/Session 2013

Instructor: Mat Brunton
Contact info: mbrunton@alaskapacific.edu
4101 University Drive
Anchorage, AK 99508
Office hours by appointment

Course Description:
Students learn the basics of snow science field work by working as field assistants for producing a weekly avalanche advisory for popular locations within the Chugach Front Range. The ability to competently document field snow, weather, and avalanche observations and conduct snowpack analyses is the focus of the course. Additionally students will learn how to integrate field data into a written avalanche advisory.

Lab fee: $100 to cover transportation and group gear.

Prerequisites:
OS 110: Winter Wilderness Skills, Avalanche Level 1, or instructor permission. A performance test on efficient rescue techniques will be conducted prior to field work. All students will need to pass this test in order to participate in field days.

Learning Objectives:
Upon completion of the course, students will:
Be able to competently conduct snowpack analyses (through snowpits and stability tests) and document snow, weather, and avalanche observations in the field
Understand national standards for documenting field observations according to *Snow, Weather, and Avalanches: Observation Guidelines for Avalanche Programs in the United States (SWAG)*
Have a basic understanding of how field observations are used in producing a written avalanche advisory for public recreation
Be safer and more competent winter backcountry travelers through practicing associated skills as part of their participation in this course

Risk management & Student Expectations:
An APU approved risk management plan (RMP) is in place for this course. At the start of the course, likely the day we spend reviewing and testing rescue skills, the RMP will be reviewed with students. Students are expected to thoroughly understand the RMP and abide by it all times in the field for this course. Students' adherence to the RMP will be a significant part of the course participation grade, which is the most important graded aspect of the course (55% of grade). Failing to abide by the RMP will not be tolerated.

Active Learning:
This course incorporates active learning through experiential field work, applied understanding of concepts, and peer/instructor collaboration. This method of learning requires participants to be actively engaged and it is imperative that students adhere to their individualized learning contract and the course RMP.

Teaching Methods:
This course is primarily field based. Students will travel, with the instructor, in the Chugach Front Range by ski or splitboard during the months of January through April. On field days students will

document field observations and help with snowpack analyses by digging snowpits and conducting stability tests. Additionally, non-field-based components of the course will consist of reading/writing assignments and learning how field data is integrated into a written avalanche advisory.

Attendance Expectations:

The course will meet for field work during the spring 2013 semester. Meeting dates, times, and locations will vary based on environmental conditions and student and instructor availability. Students will commit to a certain number of hours of field work appropriate to the number of credits (1-3) they are registered for and this will be documented in an individualized student learning contract. All sessions are required, as specified in the learning contract. If you must miss a session or will be late, please make prior arrangements and let the instructor know at least 24 hours in advance.

This class is field based and requires winter backcountry travel. Please be prepared for this in addition to traditional academic preparedness. Proper equipment and attire is your responsibility. Avalanche safety and some winter backcountry travel gear is available for rent through the OS Equipment Room.

You can drop the course prior to the “census date” this semester, which is *** After that, the course will appear on your transcript.

The last day to withdraw from the course and receive a “W” on your transcript is ***.

To drop or withdraw from the course, you must contact the Registrar’s Office via your APU email (send notice to drop or withdraw to regoff@alaskapacific.edu) or submit a form in person.

Communication Expectations:

Timely communication is essential for success in this course.

From “me” the instructor:

- The best way to reach me outside of our field days and other meetings is through email. I read my APU email daily Monday through Friday. I will try to respond to your email within 24 hours Monday – Friday, but often you won’t get a reply from messages sent on a Friday or the weekend until the following Monday. If the matter is urgent, please contact me by phone.

For “you” the participant:

- I will expect that you are reading APU email daily Monday – Friday and that you reply within 24 hours except for weekends. I will also expect that you contact me with questions and problems as soon as you need assistance. At the start of the course you’ll be asked for contact information, including your APU email and a phone number, in order that you be notified in case a problem or issue arises.

Citizenship, Plagiarism, and Cheating:

For this course you are required to exchange email, participate in field days, and collaborate with the instructor and other students. These activities should be considered professional rather than casual. Language should be respectful and representative of an academic environment.

You are expected to do all work assigned, do it honestly and with integrity, and ensure that the instructor has received your work. Cheating, plagiarism, copying online sources, and submitting the work of others as your own are all examples of prohibited conduct. Similar actions and this sort of behavior will not be tolerated and students who do not abide by these guidelines will be subject to disciplinary measures, which may include failure in the course and expulsion from the university.

Support Services:

IT Department:

- 907-564-8350

Disability-related accommodations:

- Please notify D.B. Palmer, APU Counseling Center Director (dbpalmer@alaskapacific.edu)

Graded Aspects of the Course:

Your grade will be comprised of the following:

Participation (field sessions)	55
Observation documentation	15
Snowpit documentation	15
Reading/writing assignments	15
Total:	**100**

Descriptions and Expectations for Graded Aspects of the Course:

Participation:

- Grade will be based upon your level of preparedness for and contributions to each field session as evidenced by your engagement and ability to competently assist with the documenting of field observations and conducting snowpack analyses appropriate to your level of experience.

Observation Documentation:

- Grade will be based on your ability to document observations while in the field and record them according to the national standards set forth in *SWAG*.

Snowpit Documentation:

- Grade will be based on your ability to dig test plus pits, some full profiles, conduct stability tests, and document findings according to the national standards set forth in *SWAG*.

Reading/writing assignments:

- Each week you will have reading/writing assignments from the texts listed below. Additionally, you will read the avalanche advisory you helped to produce through your field work. Grades will be based on ability to convey an understanding of the readings in your own writing. Additionally, when reading the weekly advisory you will identify how field observations for this course were integrated into the advisory and its implications for backcountry users that week.

1-3 Credit Work Loads

This course can be taken for 1-3 credits. Each credit you take the course for will require a 30 hour commitment for field work (documenting snow, weather, and avalanche observations) and another 15 hour commitment for associated academic work (completing the weekly reading/writing assignments) over the course of the semester. Dates and times you commit to for conducting field work will be flexible, based on mutual availability between you and the instructor, and determined once student enrollment is known.

Grading Policies & Procedures:

Students will receive regular feedback as to their performance in the course and whether or not they're meeting the expectations of their individualized learning contract.

If, for some reason, you feel that you may not be able to meet the expectations outlined in your individualized learning contract please contact me as soon as possible so that we can explore alternatives and find a viable solution.

READINGS

All Weather Snow & Avalanche Field Notebook - 4th Edition (available online via http://wasatchtouring.com/prod-20.htm)

**or other appropriate field notebook with instructor approval*

Snow, Weather, and Avalanches: Observation Guidelines for Avalanche Programs in the United States – 2010 Edition

Staying Alive in Avalanche Terrain by Bruce Tremper - 2nd Edition

Other readings, such as journal articles, may be assigned later.

Appendix L – Risk Management Plan

MSOEE thesis project risk management plan for instructing Outdoor Studies undergraduate snow science directed study courses and independent field days during the spring semester 2013

Description: As part of my MSOEE thesis project I will be instructing undergraduate outdoor studies students in field based directed study courses and conducting independent field days. Students in the directed study courses will gain snow science field work experience gathering mountain snow and weather data in order to produce an avalanche advisory for popular locations within the Chugach State Park. I will also be conducting independent field days in order to gather the necessary data to produce this avalanche advisory. This document will serve as the risk management plan for independent field days and field days with undergraduate students, which will be approximately 2-12 hours each and take place from the start to the end of the spring semester 2013 depending on conditions and the availability of participants.

Learning Objectives: Improve winter backcountry travel and snow science field work skills in the process of gathering mountain snow and weather data necessary for producing an avalanche advisory product for popular locations within the Chugach State Park as part of an MSOEE thesis project.

Participants: In addition to myself will be accompanied on independent field days by at least one experienced partner listed below (other partners that meet the experience-level criteria may be added later after approval by OS department chair Paul Twardock, or Dave McGivern in Paul's absence). Other participants include the undergraduate students taking snow science directed study courses during the spring semester 2013. These experienced partners and undergraduate participants, alternatively, will also serve as in-town contacts on days during which they do not accompany me in the field. Field days for this project will not be conducted without the availability of at least one of these participants in the field with me and another as in-town contact. Partners for independent field days will be present to assist in snow science work, digging pits, preparing stability roses, and gathering other data necessary for producing the avalanche advisory. Undergraduate participants will be present to complete field time for their directed study courses, gain snow science and winter backcountry travel experience, and assist me in producing the avalanche advisory. Participants in the field will stay together at all times during field days. Expectations for each field day will be discussed before leaving town and a debriefing will take place upon our return. Safe winter backcountry travel protocol will be adhered to at all times and terrain management will be a constant and ongoing discussion topic during independent field days. *See Communication section for more information on experience level of project designer and participants.*

Travel Route & Plan:

- Independent field days and field days with undergraduate OS students will take place in mountainous terrain, and at times in avalanche terrain, with associated risks. The primary field locations will be within Chugach State Park, in order to produce an avalanche advisory for popular locations. More specifically, we will be primarily conducting field work within day trip accessible terrain from the Canyon Road (primarily the north side of the Rabbit Creek drainage), Glen Alps (primarily the Little O'Malley to False Peak ridge), Arctic Valley (around Mt. Gordon-Lyon), South Fork (North Bowl area), and Harp Mountain (Harp Mtn, Lynx, 2-Bowls, 3-Bowls) trailheads. In the case of undesirable conditions within Chugach State Park, field work locations might also include the Hatcher Pass area Talkeetna Mountains and other day trip accessible locations within the Western Chugach (Turnagain Arm, Turnagain Pass, Girdwood, Summit Lake areas) in order to meet learning objectives. Specific location, participants in the field day, in-town contact, and itinerary for the day of touring will be established and communicated according to APU policies and protocol before leaving Anchorage for each field day (more on communication protocols for field days below). An electronic "Field Trip Plan" will be filed online via APU's website (MYAPU – Community – Risk Management – Off Campus Risk Management – Field Trip Planner) each morning before leaving for a field day.

- Itinerary: Will be filed electronically via MyAPU and a detailed plan discussed with participants and the in-town contact before leaving for field days.

Potential Risks & Hazards: As the course entails driving to and from Anchorage for up to 75 minutes one way to reach field locations as well as backcountry touring in avalanche terrain there are inherent associated risks and hazards including, but not limited to, extreme weather, avalanches, driving/road conditions, vehicle problems, experience level of participants, equipment failure, rugged terrain, other recreationists in the area not associated with this project, accidental loss of control, exposure, injury, dehydration, exhaustion, route finding, wildlife encounters, etc.

Plan for risk reduction and hazard avoidance:

- Weather: Field days will take place weather and snow conditions permitting. Location and route for the day will be appropriate to weather and snow conditions. Participants will be briefed in regard to weather and snow conditions before going into the field.
- Avalanches: Participants will conduct beacon checks before leaving the trailhead, follow safe travel protocols, be aware of current conditions, anticipate possible changes, plan route accordingly, practice rescue skills, discuss escape routes before descents, make terrain management an ongoing discussion during field days, and always have a plan for managing a worst-case scenario. Terrain will be appropriate for weather and snow conditions as well as experience, comfort, and skill level of participants. Field days when backcountry snowpack conditions are characterized by "extreme" avalanche danger will be canceled. Field days with "high" avalanche conditions will either be cancelled or take place in areas on the outskirts of avalanche terrain to get an idea of snowpack behavior in representative, but safe locations of where people would like to recreate when avalanche conditions improve. Field days characterized by "considerable" avalanche danger will be spent on low angle terrain. When conditions improve to "moderate" and "low" field days will commence under the assumptions outlined below. Definitions for "extreme, high, considerable, moderate, and low" avalanche conditions are defined by the North American Public Avalanche Danger Scale. Field days will commence under the assumption that avalanche conditions are unstable. Travel route will initially be on the outskirts of avalanche terrain. Participants will further assess conditions in the field to test the assumption of unstable conditions gradually. First, by paying close attention to any "bull's eye clues" or "red flags" indicating instabilities, such as whoomphing, collapsing, settling, or cracking in the snowpack as well as signs of recent avalanches in the area. Second, by traveling on and testing relatively safe slopes (small and low angle) for snowpack behavior. Third, by gradually entering into avalanche terrain on lower angle slopes (<30), assessing their stability, and if conditions permit increasing the slope angle gradually while continuing to assess snowpack conditions. Once in avalanche terrain, travel will be done by the safest means possible such as via ridgelines, bare areas of the mountain, or through potential slide paths with the safest runout. *Undergraduate participants' rescue skills will be tested prior to backcountry field days. They must be able to locate two buried transceivers within a 30m x 30m area in 6 minutes.*
- Poor driving/road conditions: If conditions are bad or anticipated to deteriorate field days will be canceled or rescheduled.
- Vehicle problems: Personal transportation used on field days is maintained and runs well, in

case of unexpected issues AAA or another appropriate service will be called upon for assistance. APU transportation may be used on field days with undergraduate students. APU policies and protocol will be followed.

- Experience level of participants: All participants are experienced with winter backcountry travel, have received at least basic avalanche education (level 1 or higher), are knowledgeable in regard to basic first aid and outdoor emergency care (1st Aid/CPR, OEC, WFR), and are practiced in regard to rescue skills which will be reviewed throughout the spring semester 2013. Participants will stay together at all times during independent field days, staying within sight or sound of one another whenever possible. A briefing with discussion of expectations for each field day will be discussed before leaving town and a debriefing will take place upon return. Safe winter backcountry travel protocol will be adhered to at all times and terrain management will be a constant and ongoing discussion topic. *Undergraduate participants' rescue skills will be tested prior to backcountry field days. They must be able to locate two buried transceivers within a 30m x 30m area in 6 minutes.*
- Equipment failure: Participants will maintain all gear used during field days in good working order, checking for functionality before and after each trip. Emergency repair gear and tools will be brought along on all outings.
- Rugged terrain: Travel route will be selected appropriately according to conditions and experience, skill, and comfort level of participants in order to mitigate associated risks and hazards.
- Other travelers in the area not associated with this project: Travel route will be selected and adjusted as necessary in order to prioritize the safety of participants.
- Accidental loss of control: All measures will be taken to ensure the terrain is appropriate for the skill, comfort, and experience level of all participants, as well as for weather and snow conditions, in order to mitigate this risk as much as possible.
- Exposure: In addition to related precautions already mentioned, traveling through exposed terrain will be avoided whenever possible and done so in the safest way possible when necessary.
- Injury: A backcountry first aid kit will be brought along on each trip and participants will have adequate knowledge to employ it appropriately (as mentioned above all participants are at least currently certified 1st Aid/CPR and most possess WFR/OEC certifications or higher), participants will be cautious for the duration of the field day and travel within their abilities.
- Dehydration: Each participant will carry sufficient personal water in an insulated container and self monitor appropriately.
- Exhaustion: Each participant will be adequately fit for the outing and self monitor appropriately.
- Route finding: I have extensive prior knowledge of and experience in all field locations. A map of the area and compass will be carried at all times.
- Wildlife encounters: Moose are the only likely risk during the season this course will take place. If encountered, participants will respect the space of the moose and leave the area. In the very rare chance of a bear encounter, participants will remain together at all times and leave any area of encounter.
- Cold injuries: Participants will be prepared for field days with adequate winter backcountry travel gear and clothing. Participants will bring waterproof layers, extra layers, and extra clothing (gloves, socks, etc.) as deemed necessary. Worst-case scenarios will be anticipated and participants will come prepared for spending more time than expected in the cold, as

well as colder than expected conditions due to wind, altitude, and other variables.

- Safety Equipment: In addition to the required tools for effective winter backcountry travel (boots, skis, skins, poles, appropriate clothing, etc.) all participants will carry extra food, water, clothing layers (puff pants and jacket, mittens), beacon, shovel, probe, and headlamp. For the group, a basic backcountry first aid kit appropriate for day trips will be carried along with a map of the area and compass, radios for communication in the field will be carried along with cell phones for emergency (although service is intermittent in some areas where field work may take place). A satellite phone, if available, will be borrowed from APU and used during field days.

Communication:

Contacts & Participants: There will be a primary in-town contact for each field day with whom participants will check-in before the day begins and as soon as it ends. This person will be available to be contacted via telephone for the duration of the field day in case of emergency or other need and will be familiar with communication and emergency protocols. Primary in-town contacts may also be participants on days they are not in the field. Additionally, there will be a primary APU contact (Paul Twardock), alternative APU contact (Dave McGivern), and local emergency contacts.

- Project designer

  Mat Brunton: ***-***-****

  - Extensive backcountry skiing experience in Alaska, Level 1 & 2 Avalanche courses through Alaska Avalanche School (will be taking Level 3 Jan-Feb 2013), Avalanche Forecasting and Mountain Weather independent study courses through Alaska Pacific University, WFR certified, advanced skier and winter backcountry traveler, prior knowledge of and experience in all terrain in which this project will be conducted

- Partners for independent field days/in-town contacts:

  Jessica Tran: ***-***-****

  - Extensive backcountry skiing experience in Alaska, Level 1 Avalanche course through Alaska Avalanche School, 1st Aid/CPR certified, advanced skier and winter backcountry traveler

  Steve Duby: ***-***-****

  - Prior backcountry skiing experience in Alaska, Level 1 Avalanche course through Alaska Avalanche School, WFR certified, advanced skier and winter backcountry traveler

  Anthony Larson: ***-***-****

  - Extensive backcountry skiing experience in Alaska, volunteer mountaineering patrol on Denali with NPS, medical doctor (MD), advanced skier and winter backcountry traveler

  Lance Breeding: ***-***-****

  - Extensive backcountry skiing experience in Alaska, medical professional, advanced skier and winter backcountry traveler

  Dave Bass: ***-***-****

  - Extensive backcountry skiing experience in Alaska, WFR certified, advanced skier and winter backcountry traveler

  Tim Griffin: ***-***-****

  - Extensive backcountry skiing experience in Alaska, WFR certified, advanced skier and winter backcountry traveler

Brian Harder: ***-***-****

- Extensive backcountry skiing experience in Alaska, previously a mountaineering guide for Exum, Physicians Assistant (PA), advanced skier and winter backcountry traveler

Rich DeJulia: ***-***-****

- Prior backcountry skiing experience in Alaska, Level 1 & 2 Avalanche courses through Alaska Avalanche School, OEC certified, advanced skier and winter backcountry traveler, Alyeska Ski Patrol for three seasons

▪ Undergraduate students

Salvatore Candela

- Prior backcountry skiing experience in Alaska, WFR certified, Level 1 & 2 Avalanche and Intro to Search and Rescue courses through Alaska Pacific University, Alaska Avalanche School instructor-in-training

Erin Pollock

- Prior backcountry skiing experience in Alaska, WFR certified, Level 1 & 2 Avalanche courses through Alaska Pacific University, trained with Alaska Mountain Rescue Group for one year

Nikolai Windahl

- Prior backcountry skiing experience in Alaska, Level 1 Avalanche course through Alaska Pacific University

Ryan Gould

- Prior backcountry skiing experience in Alaska, WFR certified, Level 1 & 2 Avalanche courses through Alaska Pacific University, rock/ice/glacier guide with Ascending Path

▪ Other participants may be added later. In order to serve as in town contact and sole partner for a field day, they will first be cleared by OS department chair Paul Twardock, or Dave McGivern in Paul's absence.

▪ Primary APU Contact:

Paul Twardock: ***-***-****

▪ Alternative APU Contacts:

Dave McGivern ***-***-****

▪ Emergency contacts:

Alaska State Troopers: 907-269-5511
Rescue Coordination Center: 907-428-7230
US Coast Guard: 888-478-5555

- Communication plan: The primary in-town contact will be notified before leaving for each field day and provided with a detailed plan for the day including specific location we will be in within the areas of Chugach State Park, Hatcher or Turnagain Pass, route, time we will return, and participants. The primary in-town contact will be familiar with the APU Emergency Response Plan and other necessary protocols. The in-town contact will be notified ASAP upon our safe return from the field. In addition, an electronic field trip planner will be filed before each outing via APU's website that will have comprehensive details for the outing and designated in-town contact for the day.

<u>Questions & Responses</u>:

- Responses to questions and concerns of the Alaska Pacific University Off Campus Risk Management Committee

- How will Mat determine "extreme" or "high" avalanche days? How many participants will go with him at one time? It should be no more than 4-5 at the most.

    While I'm not currently employed as a "professional forecaster," and considering that many established avalanche advisory programs (CNFAIC-Summit Lake, HPAC) don't label their advisories with the danger scale, I will use my best judgement (from ongoing field assessment, weather forecasts, and observations from others) as well as an extrapolation from the danger rating provided by the CNFAIC to determine the danger rating for field days. I'm not going to push the envelope, and field days will only take place conditions permitting. In the RMP you have already reviewed, there's a lengthy discussion of how terrain will be approached according to conditions (e.g. canceling field days when it's bad, starting with an assessment of the snowpack on the fringes of avalanche terrain (slope angles < 20), gradually easing our way into terrain >20 degrees, staying in forested or brushy terrain with no exposure and a relatively safe runout, etc.).

    There will likely only be one or two other participants with me on any given field day. The way things are looking, field days will primarily fall under the "independent field day" category as described in the RMP. Independent field days are when I'm accompanied by participants listed in the RMP that are not APU students, just qualified ski partners from the community. I've already done two independent studies working in avalanche terrain with an APU OCRMC approved RMP for field days for these courses. If and when there are field days with APU undergraduates, there will be no more than three undergraduates and myself. However, I doubt there will ever be more than two undergraduates and myself on these field days - likely just myself and one other.

- Does APU insurance cover a masters student and undergraduates doing field work in avalanche terrain? Does Mat have to be an adjunct to fall under APU insurance?

    As far as APU insurance is concerned, I don't know any details here. However, I've been an adjunct teaching GS102 through the LS department since Fall 2011. There are two students showing up in my faculty portal as registered to do field work with me for credit this spring. I'm listed as the primary instructor for their directed studies.

- Will Mat be bringing a sat phone? Can he insure cell coverage where he will be?

    I would be glad to bring a sat phone on all field days, especially field days with APU undergrads, if APU has one available for my use. The core advisory zones (which you can see on the map in the appendix of the thesis proposal) are all within cell phone coverage - at least at the ridgetops.

- As I understand it, the most dangerous slope angles for avalanches are 35-40; will Mat be in areas with that angle? He mentions staying under 30 when avalanches are "extreme", but what about when avalanches are moderate?

This year is going to be an extremely tricky snow year; a horrible base exists. Wendy Wagner, CNFAIC forecaster, said that yesterday, almost every foot step set off an avalanche. This is an entirely different year than last year and serious caution needs to be exercised. I think it is important for Mat's plan to acknowledge serious caution and to define how he is going to figure out "extreme" or "high" avalanche days and not to venture out on those days.

The dangerous slope angle equation is more complex than 35-40, but those are the primary angles people like to ride and where most avalanche incidents have occurred (I think 38 has been determined to be the most dangerous in this regard). On days of "extreme" danger we won't be in avalanche terrain and field days will be cancelled. On days of "high" danger field days will also likely be cancelled, or at the very least will take place well outside of avalanche terrain and only be conducted to get an idea of snow and weather conditions from safe locations. Even on days with "considerable," "moderate, and "low" danger, slopes in avalanche terrain and above 30 degrees will be approached gradually, with caution, and under the assumption they're unstable due to snowpack variability. In addition to slope angle, there are numerous other considerations that will be taken into account when choosing appropriate terrain for the day such as exposure, runout, skier ability, etc.

As far as this year's snowpack goes, it is very different than last season's at this time of the year. Hopefully the storms will start rolling, we'll get more precip, temperatures will be more conducive to a stabilizing metamorphism of the snowpack, and eventually we'll have conditions for good, safe skiing. The Front Range and Eagle River area snowpack is very different than the snowpack for which the CNFAIC forecasts. While Turnagain region has a thick base of facets with possibly more than one layer of buried surface hoar, the Front Range and Eagle River area snowpack was practically non-existent before the most recent storm which deposited relatively heavy, wet snow that will hopefully provide us with a less faceted base. Nonetheless, due to the Front Range snowpack always being thinner than down South's, it is a different scene altogether. I've been an avid skier in the Front Range and Eagle River area for several years, during relatively "good" and "bad" seasons, and I'm confident in my assessment and ability to manage terrain appropriately. Again, I can't stress it enough, I will not be pushing it on field days for this project and will exercise caution and approach things conservatively.

Appendix M – Example of access-restricted website advisory:

02-16-2013

Bottom Line:

Moderate Hazard (***see the danger scale***): primarily for wind slabs around certain terrain features. Wind slabs created from the 9-10" dump at the beginning of the week formed during a period of strong midweek winds and are now covered, and likely hidden, by several inches of fresh snow from Friday. New, shallower, and relatively soft wind slabs, as well as sluffing, are also possible in our fresh snow from Friday.

Primary Concern:

Deeper wind slabs 3-8" thick formed midweek near peaks, ridges, in upper alpine bowls, and in other deposition and catchment areas (i.e. flanks of cross-loaded gullies). These wind slabs are likely to be covered and hidden by several inches of new snow from Friday.

Secondary Concern:

Relatively soft wind slabs 3-6" thick that have formed, or are forming currently, from Friday's new snow. These are likely only problematic at the uppermost elevations (near peaks and ridges), as winds have been relatively calm during our most recent deposit of new snow. Loose snow avalanches (sluffing) in steep terrain is also possible in Friday's new snow.

In general, small wind slabs and sluffing are possible in the steeper sections of the standard-fare Front Range ski runs. While likely not pulling out enough snow to be buried, one could take an unpleasant ride.

I would approach these areas with more caution: steeper north facing runs (such as those accessed from Arctic Valley) and the bowls and gullies accessed from Hiland Road (Lynx, 3 Bowls, Harp, etc. – I have less data on conditions here). I would avoid steep north facing couloirs altogether this weekend as the snowpack is still relatively thin and weak and the likely numerous wind slabs need more time to bond.

Please remember the snowpack is still thin and, as always, the Chugach Front harbors many lightly covered rocks. Watch out for shark attacks!

Mountain Weather:

Expect partly sunny to partly cloudy skies with light winds and mountain temperatures in the teens. Don't be discouraged by seemingly low visibility in town in the morning. It is likely just low hanging fog and the upper hillsides are probably above it – check the webcams in this regard.

Further Snowpack Discussion:

It is hard to say how hidden and reactive the more deeply buried wind slabs (primary concern) are, due to low visibility and the resulting hindered mobility to poke around in the snowpack on Friday. However, findings from the Canyon Road area suggest relatively low energy and moderate strength in these buried wind slabs. Hand pits on the way up Peak 3 revealed 3-4" thick, 1F hard wind slabs with a faceting base sitting on top of our old melt-freeze/rain crust at mid elevations. These wind slabs were covered by 3" of new snow by Friday afternoon. I'm not too concerned about a problem here.

However, in the upper alpine bowl of Peak 3 and near the summit there is significantly more new snow (~6" by Friday afternoon). The wind slab here, formed by midweek winds from the snow deposited at the beginning of the week, is buried deeper and is a significantly thicker slab (6-8"). I was actually able to find a couple layers of wind slab at the upper elevations, with thin layers of softer snow sandwiched between – the bottom most wind slab sitting atop the melt-freeze/rain crust and with a faceting base. This crust is buried well over a foot deep in the upper elevations. Hand pits approaching the summit revealed easy failures in the new snow as a very soft slab ~6" thick. A decent pull on the column was required to get anything to fail beneath the new snow (the buried wind slabs from midweek).

Disclaimer

Warning!!! If you choose to use any information found on this website you do so at your own risk. No individuals, organizations, or institutions associated with the Anchorage Avalanche Center assume any responsibility or liability, whatsoever, for how information provided by this website is used. Information provided here is, at best, one piece of the puzzle in effectively evaluating backcountry snow conditions and avalanche hazard. Weather, snow, and avalanche conditions are dynamic and constantly changing. Information provided here is but a small, static snapshot of this dynamic phenomena. Thus, it is not widely applicable across space and time. In order to effectively use and apply the information found on this website you need to be educated and experienced in regard to avalanche safety, hazard recognition, and rescue. It is imperative that you receive avalanche education from a professional provider, carry all essential rescue equipment (beacon, shovel, and probe in addition to all tools and at- backcountry travel), and understand inherent risks before venturing into avalanche terrain. Again, the Anchorage Avalanche Center and all associated individuals, organizations, and institutions (public and private) assume absolutely no liability or responsibility for the use of information provided on this website.

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Appendix N – Example of publicly-accessible website advisory:

Anchorage Avalanche Center (AAC)

Providing snow, weather, and avalanche information for the Front Range and Eagle River area Chugach

HOME ADVISORY OBSERVATIONS WEATHER WEBCAMS DANGER SCALE DISCLAIMER ABOUT CONTACT THE AAC

April 8, 2013

Advisory based on observational knowledge and weather forecast available at the time of posting. Accuracy is subject to temporal and spatial variability. Read the disclaimer and conduct your own assessment of conditions accordingly. Accuracy expiration is less than 24 hours.

Monday:

Danger Level	Travel Advice	Likelihood of Avalanches	Avalanche Size & Distribution
3 Considerable	Dangerous avalanche conditions. Careful snowpack evaluation, cautious route finding and conservative decision-making essential.	Natural avalanches possible; human-triggered avalanches likely.	Small avalanches in many areas or; large avalanches in specific areas or; very large avalanches in isolated areas.

see the complete danger scale

What you need to know:

Dangerous avalanche conditions exist and will likely persist through Tuesday. Travel in avalanche terrain is not recommended unless you possess expert-level backcountry travel, hazard evaluation, and decision-making skills.

A winter weather advisory is currently in effect for the Anchorage Avalanche Center's advisory area.

The avalanche danger is again increasing back to considerable where it will likely remain through Tuesday. Expect the peak in avalanche danger to be late Monday through early Tuesday, as the possibility for another 1-2′ of new snow is once again on tap for our local mountains. There is the possibility of the avalanche danger trending towards high in some areas. New snow will be sitting on the existing 1-2′ (on average) of snow from the Saturday-Sunday storm.

If the snow abates Tuesday and winds remain light as currently forecast, a gradually decreasing avalanche danger trend should begin later in the day on Tuesday as the snowpack begins to ad-

DONATE TO THE AAC

100% of your donation directly supports the Anchorage Avalanche Center, currently a grassroots and volunteer effort, and will provide for further developing its avalanche advisory products. The sustainability of the AAC depends on the support of its users and the local community. It is not funded by federal, state, or local land managers. Ensure the future of this recreational avalanche advisory program for seasons to come by making a tax-deductible donation today! Part of the Alaska Avalanche Information Center network of non-government avalanche centers, the AAC is a 501(c)3 non-profit organization. Federal Tax ID (EIN): 80-0674646

Donate

DISCLAIMER

Information provided here is one piece of the puzzle in effectively evaluating backcountry snow conditions and avalanche hazard. Weather, snow, and avalanche conditions are constantly changing and we are only able to provide small, static snapshots of this dynamic phenomena. In order to effectively use

Follow

Appendix O – List of avalanche centers in the United States by type and funding

Type 1: **Utah Avalanche Center (UAC):** Salt Lake City, UT

provides information for Logan, Ogden, Salt Lake, Provo, Uintas, Skyline, and Moab area avalanche terrain

cooperatively funded by state (~22%), federal (~22% USFS), and private (~56% non-profit Friends group) agencies

- ~$525,000/season operating budget
- sourced from UAC 2012-13 annual report

Northwest Weather and Avalanche Center (NWAC): Seattle, WA

provides information for Cascade, Olympic, and Mt. Hood area avalanche terrain

cooperatively funded by state (~38%), federal (~35% USFS), and private (~27%) agencies

- ~$350,000/season operating budget
- sourced from NWAC 2011-12 annual report

Gallatin National Forest Avalanche Center (GNFAC): Bozeman, MT

provides information for Bridger, Gallatin, Madison, Cooke City, and West Yellowstone area avalanche terrain

cooperatively funded by state (~23%), federal (~55% USFS), and private (~22% non-profit Friends group) agencies

- ~$200,000/season operating budget
- sourced from GNFAC 2012-13 annual report

Colorado Avalanche Information Center (CAIC): Boulder, CO

provides information for Steamboat & Flat Top, San Juan, Sangre de Cristo, Front Range, Sawatch, Vail & Summit County, Aspen, Gunnison, and Grand Mesa area avalanche terrain

cooperatively funded by state (primary source of income), federal (~30% USFS), and private agencies

- ~$150,000/season operating budget (for backcountry advisories only)
  - this is only a fraction of operating budget as backcountry avalanche information is only one component of CAIC operations
- sourced from 2001 NAC business plan

Chugach National Forest Avalanche Information Center (CNFAIC): Girdwood, AK

provides information for Girdwood, Eastern Turnagain Arm, Turnagain Pass, and Summit Lake area avalanche terrain

cooperatively funded by federal (~50% USFS) and private (~50% non-profit Friends group) agencies

- ~$150,000/season operating budget
- sourced from CNFAIC 2012-13 annual report

Sierra Avalanche Center (SAC): Truckee, CA

provides information for Central Sierra Nevada area avalanche terrain

cooperatively funded by federal (~35%) and private (~65% non-profit Friends group) agencies

- ~$145,000/season operating budget
- sourced from SAC 2012-13 annual report

Mount Washington Avalanche Center (MWAC): Gorham, NH

provides information for Mt. Washington area avalanche terrain (primarily Huntington and Tuckerman ravines)

primarily federally funded (~100% USFS)

- ~$100,000/season operating budget
- sourced from 2001 NAC business plan

Type 2: **Sawtooth Avalanche Center (SAC):** Ketchum, ID

provides information for Sawtooth, Wood River valley, Smoky & Boulder, and Soldier area avalanche terrain

cooperatively funded by state (~4%), federal (~51%, 47% USFS + 4% BLM), and private (~45% non-profit Friends group) agencies

- ~$125,000/season operating budget
- sourced from SAC 2012-13 annual report

Bridger-Teton Avalanche Center (BTAC): Jackson, WY

provides information for Teton, Togwotee Pass, and Grey River area avalanche terrain

cooperatively funded by state, federal, and private (~50% non-profit Friends group) agencies

- ~$50,000/season operating budget
- sourced from BTAC and F-BTAC websites and 2001 NAC business plan

Mount Shasta Avalanche Center (MSAC): Mt. Shasta, CA

provides information for Mount Shasta area avalanche terrain

primarily funded by USFS with assistance from non-profit Friends group

- ~$50,000/season operating budget with most income provided by USFS
- sourced from 2001 NAC business plan

Type 3: **Payette Avalanche Center (PAC):** McCall, ID

provides information for Payette and Boise National Forest area avalanche terrain

cooperatively funded by federal (~70% USFS) and private (~30% non-profit Friends group) agencies

- sourced from 2001 NAC business plan

Idaho Panhandle Avalanche Center (IPAC): Coeur d'Alene, ID

provides information for Idaho Panhandle National Forest area avalanche terrain

cooperatively funded by state, federal (USFS primary source of income), and private agencies

- ~$20,000/season operating budget
- sourced from 2001 NAC business plan

West Central Montana Avalanche Center (WCMAC): Missoula, MT

provides information for Bitterroot, Rattlesnake, Southern Swan, and Mission area avalanche terrain

funded primarily by non-profit Friends group with significant in-kind contributions from USFS employees

- ~$20,000/season operating budget provided by non-profit Friends group
  - ~$35,000 in-kind contributions from local USFS employees
- sourced from 2012-13 season summary

Flathead Avalanche Center (FAC): Kalispell, MT

provides information for Flathead, Swan, Whitefish, and Kootenai area avalanche terrain

cooperatively funded by state (~40%) and federal (~60% USFS) agencies

- ~$25,000/season operating budget
- sourced from 2001 NAC business plan

Eastern Sierra Avalanche Center (ESAC): Mammoth Lakes, CA

provides information for Eastern Sierra Nevada area avalanche terrain

cooperatively funded by state, federal, and private agencies

Crested Butte Avalanche Center (CBAC): Crested Butte, CO

provides information for Crested Butte area avalanche terrain

community-based, non-government, non-profit avalanche center funded by donations and grants

- ~$28,000/season operating budget
- sourced from 2011-12 annual report

Type 4: **Wallowa Avalanche Center (WAC):** Joseph, OR

provides information for Wallowa & Whitman National Forest and Northeast Oregon State Parks area avalanche terrain

Kachina Peaks Avalanche Center (KPAC): Flagstaff, AZ

provides information for Kachina Peaks wilderness area avalanche terrain

Alaska Avalanche Information Center (AAIC) network:

Valdez Avalanche Center (VAC): Valdez, AK

provides information for Valdez and Thompson Pass area avalanche terrain

part of the AAIC network of non-government, non-profit avalanche centers

- funded by donations, grants, and contracts
- part-time, volunteer staff

City of Cordova Avalanche Conditions: Cordova, AK

provides information for Cordova area avalanche terrain

part of the AAIC network

- funded by contract with City of Cordova

Haines Avalanche Information Center (HAIC): Haines, AK

provides information for Haines area avalanche terrain

part of the AAIC network of non-government, non-profit avalanche centers

- funded by donations

- part-time, volunteer staff

Hatcher Pass Avalanche Center (HPAC): Chickaloon, AK

provides information for Hatcher Pass area avalanche terrain

part of the AAIC network of non-government, non-profit avalanche centers

- funded by donations
- part-time, volunteer staff

Anchorage Avalanche Center (AAC): Anchorage, AK

provides information for Front Range and Eagle River area avalanche terrain

part of the AAIC network of non-government, non-profit avalanche centers

- funded by donations
- part-time, volunteer staff

Appendix P – List of important initialisms

AAA:	American Avalanche Association
AAIC:	Alaska Avalanche Information Center
AAS:	Alaska Avalanche School
APU:	Alaska Pacific University
AAC:	Anchorage Avalanche Center (AAIC network)
AMRG:	Alaska Mountain Rescue Group
ANSP:	Anchorage Nordic Ski Patrol
ASP:	Alaska State Parks
CAIC:	Colorado Avalanche Information Center
CNF:	Chugach National Forest
CNFAIC:	Chugach National Forest Avalanche Information Center
CSP:	Chugach State Park
CSPAIC:	Chugach State Park Avalanche Information Center (hypothetical avalanche center)
CSPCAB:	Chugach State Park Citizen's Advisory Board
F-CNFAIC:	Friends of the Chugach National Forest Avalanche Information Center
F-CSP:	Friends of Chugach State Park
HPAC:	Hatcher Pass Avalanche Center (AAIC network)
MSOEE:	Master of Science Outdoor & Environmental Education
NAC:	National Avalanche Center (USDA Forest Service)
NAOI:	North American Outdoor Institute
NPS:	National Park Service
NWAC:	Northwest Weather & Avalanche Center (Oregon & Washington)
NWS:	National Weather Service
OS:	Outdoor Studies (APU academic department)
RMP:	Risk Management Plan
SAC:	Sawtooth Avalanche Center
SWAG:	*Snow, Weather, and Avalanches: Observation Guidelines for Avalanche Programs in the United States* (text)
UAC:	Utah Avalanche Center
USDA:	United States Department of Agriculture (federal government executive department)
USFS:	United States Forest Service (agency of the USDA)
VAC:	Valdez Avalanche Center (AAIC network)