

Avalanche

REVIEW

VOLUME 28, NO. 1 • OCTOBER 2009

www.AmericanAvalancheAssociation.org

Season Roundup 2008/09

December 17, 2008
Toledo Bowl
Little Cottonwood Canyon, Utah
Photo by Bruce Tremper

There we were! I was up with Liam Fitzgerald and the boys looking at a human-triggered avalanche in the nearby bowl when we got a call that someone triggered this slide. Liam and I went over to have a look. We talked with the folks who triggered it. The tracks tell the story.

Four people skied the straight south facing slope, then the fifth decided to put a track in where it wraps around a little east facing. He collapsed the slope and it pulled out the slide above and to the side, and he scooted off and was not caught.

It was the first avalanche of the big avalanche cycle. The notorious depth hoar with a rain crust on top with more facets above the crust was slowly being overloaded by new snow. The south-facing slopes were very stable, but as soon as you wrapped around to the east, you were in a different world. It's a common scenario in depth hoar climates where people get a quick education in the importance of aspect.

These folks lived to tell the tale and I got a great educational photo in the process.

Forest Service National Avalanche Center

The Forest Service National Avalanche Center (FSNAC) thanks and congratulates all of you in the snow-safety industry for your hard work and dedication. This past winter was, in many ways, particularly difficult for those of us who deal with snow risk reduction.

The events of December 2008 will remain etched in our psyches forever. There has never been a season, much less a month, in the history of the US ski industry when we have suffered as many inbound incidents and fatalities. The mainstream media attention was intense; printed and electronic sources including *The New York Times*, *The Denver Post*, and the *Los Angeles Times* as well as all the major TV and radio networks featured prominent stories that asked virtually the same question: Is it safe to ski in US ski areas? The resounding answer given by the FSNAC, the National Ski Areas Association, and other industry sources was, "Yes."

Granted, inbound avalanche danger to the public exists. Snow is a very complex medium, and snow safety crews using state-of-the-art mitigation techniques including explosives can reduce the avalanche danger to almost zero, but they cannot totally eliminate it. The US ski industry typically has around 57-million skier visits each year; using a conservative estimate that 15% of those visits involve

skiing steep, open, and un-groomed terrain means that there are 8.5-million skier visits to inbound avalanche terrain. The statistical odds of getting caught in an open area, regardless of where a person skis, are miniscule. And the reason the odds are miniscule is that ski patrollers routinely risk their own lives to keep it that way; a fact dramatically driven home this March when Andrew Entin tragically died doing control work at Squaw Valley.

And ski patrollers aren't the only ones who routinely stand between avalanches and the public. Highway forecasters, backcountry forecasters, guides, and artillery crews often spell the difference between catastrophe and a great day for the public.

The FSNAC is dedicated to avalanche-risk reduction. Our job includes helping provide the latest technical information to practitioners, coordinating the FS backcountry avalanche centers, supporting avalanche education, and managing the FS national military artillery for avalanche control program. We salute all of you who work to reduce avalanche risk; we are proud to be part of your network.

—Doug Abromeit, director
Karl Birkeland, avalanche scientist ❄️

See NAC summaries beginning on page 19 ➡

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Research suggests that one patroller's injury can indirectly cause injuries to other patrollers.

—Ron Simenhois and Scotty Savage
Professional Avalanche Near Misses, p16

metamorphosis

Longtime WSDOT employee **Marty Schmoker** has retired. Marty began his career with the WSDOT in 1977 and has been the avalanche supervisor on Stevens Pass since 1992. Marty is well known for his involvement with the AAUNAC and his commitment to utilizing surplus military artillery for avalanche control. We all wish Marty lots of happiness in his retirement and look forward to training with him through Artillery Concepts.



Marty Schmoker

Mike Stanford was recently selected to fill the position of avalanche supervisor for the WSDOT on Stevens Pass. Mike has been with the WSDOT since 1990 (seasonally), becoming a permanent employee in 1992. Mike is excited to meet the challenge of his new job.



Mike Stanford

Photos by John Stimeris

From Doug Chabot at the GNFAC:



Eric Knoff

Eric Knoff, 34, joins the staff of the Gallatin National Forest Avalanche Center this winter. Eric was hired as an avalanche specialist and comes to the job with years of work in the snow industry. Eric graduated from Montana State University with a degree in physical geography, then worked with the NRCS in Bozeman as a cartographic technician. In 2002 Eric moved to Utah and became a professional ski patroller at Snowbird Ski and Summer Resort where he patrolled for the next six winters. During the summer months Eric worked as a professional mountain guide from 2001 to present for Exum Mountain Guides, Rainier Mountaineering, Inc., and Mountain Link. He has guided trips from Alaska to South America and has been a two-time instructor for the Khumbu Climbing School in Phortse, Nepal.

Mark Staples and I are excited to have Eric as part of our team. He'll be a valuable addition to the GNFAC and professional avalanche community. ❄️

David LaChapelle Passes Away

Silverton resident David LaChapelle died from complications of throat cancer in Durango on Tuesday, July 21, 2009. He was 56.

Known as "Randy" as a child, he was born to Edward R and Mary Dolores Greenwell LaChapelle in Denver on October 8, 1952. He and one other child were taught in a one-room schoolhouse by his mother in Alta, Utah, during the winter months, and he attended public school in Kirkland, Washington, during the rest of the year.

LaChapelle spent summers with his parents in a small cabin on the Blue Glacier in the Olympic Mountains and learned the complexities of glacier research. He later attended Woodside Priory in Northern California and the University of Washington for a short time.

His parents moved to Silverton about 30 years ago for avalanche research. After their divorce, Mrs Dolores LaChapelle became well known for her writing and teaching in the San Juan Mountains until her death in January 2007. At that time, LaChapelle and Ms Foley moved into her Silverton home.

From a young age, LaChapelle was an expert skier and wilderness guide. He later took more than 200 groups into the wilderness.

He was trained in a variety of body therapies and yoga psychology, received eight years of clinical supervision in psychology with a physician and was initiated into Native American healing traditions by John Fire Lame Deer, a Lakota medicine man.

In 1981, he co-founded Wellspring Partners in Health, a holistic medical clinic in Boulder, where he had a private practice as a transpersonal psychotherapist and spiritual counselor. Throughout the 1980s, he was an adjunct faculty member teaching group process at Naropa Institute and directed the counseling program at the September School, a private high school, both in Boulder.

In 1988, he moved to Juneau, Alaska, where he continued his work with groups and where "Stories of the Soul" became the focus of his work. His creative focus turned to writing, and his books included *Navigating the Tides of Change*, *Mountains of Light*, *A Voice on the Wind*, *A Hymn of Changes*, and *The Storyteller's Mirror*.

LaChapelle is survived by his companion of six years, Ananda Elise Foley, of Silverton; his father's companion of 20 years, Meg Hunt, of Olympia, Washington; and several aunts and cousins.

reprinted by permission from the Durango Herald ❄️



A group of local friends recently threw a "lateral transfer party" for Denny Hogan at casa de Jerry. Denny left his snow ranger job in Silverton, but they gave him another job in Silt (home near Glenwood) with 3 months off in the winter! What could be better, que no? l-r: Frank Coffey, Denny Hogan, Pat Ahern, Peter Shelton, Jerry Roberts, Mike Friedman. *Photo by Lisa Issenberg*

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Senator Beck Study Plot, photo courtesy Center for Snow and Avalanche Studies

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WHEN MEASUREMENTS MATTER

HAL BOYNE: In Memoriam

Story by Kelly Elder

The avalanche and snow-research communities lost a long-term colorful colleague, contributor, and friend when Harold (Hal) S Boyne passed during post-operative complications January 26, 2009, in Denver. Hal celebrated his 80th birthday with his daughters and other family members on December 26, 2008. Hal was a long-term member of the American Avalanche Association education committee and served a term as president of the AAA as well.

Son of an auto mechanic, Hal was born on the East Coast in 1928 and raised on Cape Cod where among other activities he caddied for the Kennedy family. He joined the navy in WWII and was ship-bound in the Atlantic. When he returned to the US, he took advantage of the GI bill and went to school. He used the training he received in the military in electronics and went from an undergraduate degree to a graduate program in physics. He received his PhD in physics from the University of Michigan, Ann Arbor, studying lasers. He was snapped up by the National Bureau of Standards in Washington, DC, where he continued research on lasers and electromagnetics.

An opportunity came up for a temporary position in Boulder, Colorado, with NBS. Hal was sick of the Washington scene and jumped on the chance. His supervisor in Washington suggested that he rent his house out so that he would have a place to return. He said, "Hell no; I'm not coming back," and he didn't. His detail in Boulder turned into an offer to be a division chief, which he accepted.

Hal became very interested in electromagnetics in the context of snow. Colorado State University was looking for a faculty member with expertise in snow to replace Jim Meiman who had become the Dean of the Graduate School. By now Hal had garnered considerable field experience working on Loveland Pass and Berthoud Pass and around the region, and he had state-of-the-art technical skills with his electromagnetics applications. When CSU asked Hal where he learned about snow, he simply said, "Don Bachman trained me."

Apparently that was good enough and Hal retired from the NBS and started a second career at CSU as a professor where he taught classes in snow, sediment and fluvial processes and geophysics in the Earth Resources Department. Working with a couple of his students, he produced the first research that showed the promise of retrieval of snowpack properties using frequency modulated, continuous wave (FMCW) radar. He continued this work in Colorado and Wyoming, and his research had international impact.



Hal had a difficult time understanding the concept of retirement, as he continued working and doing research well after he retired from Colorado State University.
Photo courtesy NOHRSC

With his strong management skills, Hal was soon tapped to become department head. He took a sabbatical at the US Army Cold Regions Research and Engineering Lab (CRREL) in Hanover, NH, where FMCW radar was also a topic of interest, although with different applications.

Hal returned from a productive sabbatical and prepared for a second retirement. It was not to be. CRREL recruited Hal to return to New Hampshire and become a branch chief. He accepted and worked there for a few more years, facilitating research for others and continuing some of his own radar work. Some of the work he and Gary Koh conducted in snow has been picked up and become the focus of a new generation of rising stars such as HP Marshall, all of whom are benefiting greatly from Hal's early efforts.

When Hal retired for a third time, he wanted to return to Fort Collins to be near the mountains, CSU, and one of his two daughters and grandson. I had just begun teaching at CSU. Hal couldn't really understand the concept of retirement, as he was still teaching from an emeritus position. We co-taught several snow courses. I had known Hal then for about a decade, but really got to know him by co-teaching and spending time with him in the field. When I left CSU he continued to help me on several large field research efforts. He was strong and fit and worked tirelessly day after day on some tough field campaigns with little complaint. I think he embarrassed some of the young field helpers who couldn't keep up with a tough old guy in his 70s.

Hal had a keen sense of humor and loved to tell jokes and stories. One of the things I loved about his stories was that they were real. The truth was good enough for Hal. He felt no need to elaborate, and so, when he told you a story, you knew it was genuine.

One of my favorite examples is a story he told about his first car. He had returned from WWII and bought a used Studebaker. He said, "Man, that thing would go!" I expected some inflated figure matching today's performance specs like 90-110 mph. He went on, "I took it from Cape Cod to New York to meet a friend and had the pedal on the floor the whole time. You wouldn't believe it, that son of a gun averaged 59 mph!" He was still so excited.



Hal (at right) attends an industry seminar in 2002 with Denny Hogan to his left.
Photo courtesy NOHRSC

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Another of his favorite stories involved a run-in with the Wyoming State Highway Patrol. Hal and other colleagues including Don Bachman were conducting some of their radar work in the huge snowdrifts behind the snow fences designed by Ron Tabler and RA Schmidt on I-80 west of Laramie. They used a backhoe and chainsaws to excavate the pits in the incredibly dense, deep, hard snow – a dream that I have long had, but never experienced. Since it was Wyoming, Hal figured they could do anything they damn well pleased. After all, they were physicists, and this was the frontier, so who would care? Turns out the highway patrol didn't like them choosing their own access points on and off the controlled access interstate system, and they were hauled into town to explain themselves. Hal still had a picture on his wall of the snowdrift, researchers, backhoe, and law officers "negotiating."

I used to like to think of Hal as a junkyard dog. He had a deep raspy voice, which intimidated some until they got to know him. He was all bark. He saved the bites for himself. Hal was always hardest on Hal and the only person I ever saw him really chew out was himself.

Locally in Fort Collins he helped many people out of predicaments, whether

he knew them well or not. For years he volunteered his time at the Crossroads Safe House for Women and served on the board of a local dance organization. He was an accomplished blues guitarist and a patron of the arts. Until his last day he had a sharp mind, open to new ideas, curious and inquisitive, and accepting of others and their alternate views and ways of life.

Don Bachman summed Hal up pretty well in a recent conversation. "Hal was fascinated by snow and an enthusiastic investigator; there was rarely a dull moment in the field (or at the motel bar or dining room) when Hal was in charge. It was great times."

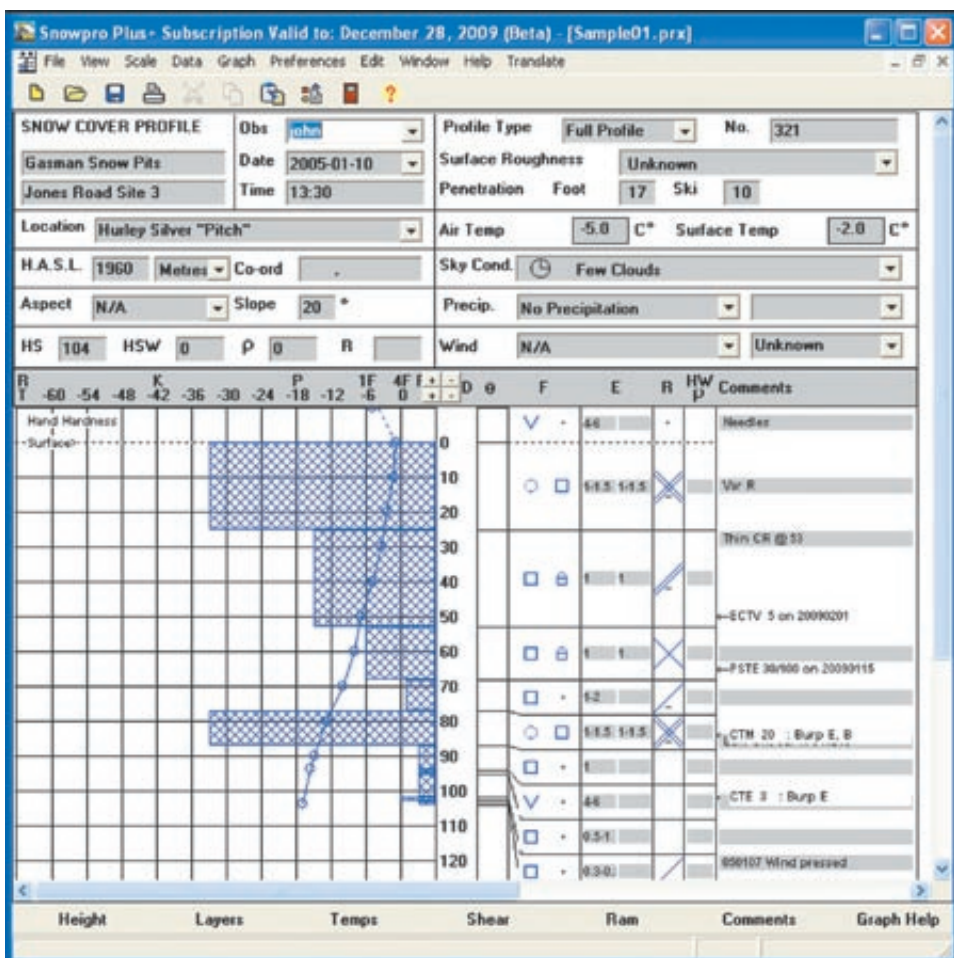
It is true. I got together with Hal about once a week for the last 8-10 years. Sometimes we just complained about bureaucrats, his computer, or our aches and pains, but mostly we liked to laugh. Hal always had a tidbit worth chuckling over. He loved science. He loved the mountains and outdoors. He loved poking around in a snowpit. He loved his daughters and grandkids. He loved a good glass of beer or wine. He never stopped loving life. We should all be so lucky.

Kelly Elder knows as much about Volvos as any snow scientist in America. He and his two new knees are on Baffin Island. ❄️

what's new

Snowpro Plus+ Subscription & New Features

Story by Gary Sims, Gasman Industries Ltd.



Snowpro Plus+ has been an industry standard snow-profile graphing software program for over 14 years and is used worldwide in the snow industry. Starting in October, Snowpro will be sold on an "Annual Subscription" basis. Previously Snowpro was sold as an individual computer license and users could buy an Annual Support License that provided upgrades and technical support.

We are combining this into a single subscription license. When you purchase a Snowpro Plus+ Annual Subscription you will get the most current software for 12 months via automatic software updates over the internet. You will also be able to access our technical support service year round with any questions or to resolve any problems. The software will allow you to view your existing profiles even when the subscription expires.

A number of new features and improvements are included in the new release. These include Shear-frame, Deep Tap, Extended Column, and Propagation Saw shear tests, shear and snow layer persistent "Nicknames," Automatic Updates, IASC 2009 grain forms symbols, CAA OGRS 2007 adherence, a new save format based on CAAML XML, data synchronization with the Avert Online Snow Science Systems "Avert Platform," and many minor improvements.

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Expatriate Steve Conger enjoys a beer at the Polar Bar at the Canadian Avalanche Association's Annual General Meeting this May.

EXPLOSIVES UPDATE: News from the North Country

Story and photos by Craig Sterbenz

After a long, cold, snowy winter one of the great things about working as a ski patroller is planning fun things to do after closing day. It's "off-season" and time to take off the ski boots, slip on the flip-flops, and head for the beach while all the dog poop thaws out and dries up. Baja beckons. The old adage around the patrol room was "Never go north before May 15th."

Sage wisdom no doubt. So, I ask myself, "Why am I headed north to Anchorage, Alaska, in early March?" Certainly not just because it's too early in the season for mosquitoes. Certainly not to see Sarah or because I've always wanted to see the start of the Iditarod (which was pretty cool) but because of the International Snow Science Workshop, ISSW. I joined long-time friend Mark Moore, from the Northwest Avalanche Forecast Center and

ISSW 1998 chair, on a "familiarization tour" of Anchorage's conference facilities to see if it would be a suitable location to host ISSW 2012.

We were impressed. The new Dena'ina Conference Center and adjacent performing arts facilities are overly spacious and state of the art. Increased travel expenses can easily be offset by the abundance of reasonably priced food and accommodations. Abundant opportunities for recreation, reasonably easy access to field trip options, and good support from the local avalanche community helped sway our decision – but Mardi Gras night at Chilkoot Charlie's clinched it. Get ready for ISSW 2012, Anchorage.

So much for never going north before May 15th. How about going to the

Dear Backcountry,
 "The Untracked Experience" to me is waking up at 5:00 a.m. with a smile on my face, knowing I'm going to blow off work for blower pow. It's running the risk of giving birth in the backcountry, just to get a few more pow turus a week before my due date. It's watching Doppler radar like it's the Second Coming, just to see if that storm will develop. It's knees shaking at the top of a big line, and smiles at the bottom. It's my boss saying, "I know. It's a powder day," before I can even tell her my excuse. It's pure stoke when I look back at a tracked out slope, knowing every turu is mine. That's what "The Untracked Experience" means to me.

Amy Flygare
 BCM Subscriber

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Canadian Avalanche Association's Annual General Meeting, May 4 to May 8 in Penticton, British Columbia?

After a long hard winter with 26 avalanche fatalities, most Canadian avalanche workers were probably looking forward to their annual spring trip to "the Moab of BC." Unfortunately, spring was late. Fortunately, the cold damp weather guaranteed good attendance at the continuing professional development seminars which focused on persistent weak layers like the one they dealt with last winter.

At the close of the sessions various awards were presented, and once again Everett Clausen, owner of CIL/Orion Explosives, stole the show with his wit, humor, and generous contributions to both the CAA and the AAA. Every year CIL/Orion contributes a percentage of their sales back to our avalanche associations to support education and continuing professional development programs. This year's contribution from CIL/Orion to AAA totaled almost \$6000! Thank you Everett!

In other explosives-related news presented at a user group luncheon, CIL/Orion was able to report that after extensively reworking its Stubby avalauncher round and tail-fin assembly, it appears that all of the previous season's bugs have been worked out. Re-designed firing pins, new shot-shell primers, and crack-resistant nylon fins are just a few of the improvements they made. Users reported firing 1000 rounds with only three misfires! Feeling pretty confident with the success of the improved Stubby avalauncher round, CIL unveiled the prototype of its new 2 kg Snow Slugger projectile.

Initial test firing in Canada and at Mount Hood Meadows in Oregon went very well. The rounds flew straight and are reported to have a range of about 75% of their 1 kg Stubby predecessor. CIL/Orion has begun pouring the new aerodynamic 2 kg projectiles which will use the same screw-on tail-fin assembly as the Stubby. Their new Snow Slugger should be available for the upcoming season.

The user group's luncheon included representatives from the Worker's Compensation Board (WCB) in British Columbia which has started requiring certification for the pressure vessels being used in avalaunchers and has sent some of the older tray-loader and McKracken launcher users scrambling.

Their WCB has also started to worry about the upcoming Winter Olympic Games and has instituted a new requirement that all explosives magazines, no matter how remote their location, be inspected DAILY! Fortunately they are permitting these daily inspections to be done by electronic surveillance. Representatives from Mag-Safe detailed their high-tech, satellite-phone-based security monitoring system which satisfies the WCB's stringent regulations. Impressive technology at a reasonable and affordable price.

That's it for now. The sun's out, the wind is blowing and I'm headed to the beach, but I'm already looking forward to slipping into my ski boots and sliding one of those new Snow Sluggers into the breach. ❄️



CIL/Orion's Dave Sly holds an inert maple prototype Snow Slugger test projectile.

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Craig Sterbenz receives a \$6000 check for the AAA from Everett Clausen of CIL/Orion during the Canadian Annual General Meeting in Penticton, BC, in May 2009. CIL/Orion donates a percentage of their annual sales to both the CAA and AAA to support avalanche education and professional development.

Photo by Mary Clayton



A time capsule was opened on Hatcher Pass when Tom Murphy of AIARE and Nancy Pfeiffer of the Alaska Avalanche School hooked up for some skiing in their old stomping grounds.

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Ortovox USA Names Dale Bard as New Chief Operating Officer

Ortovox USA has appointed Dale Bard Chief Operating Officer. Bard, a legend among American rock climbers and alpinists, brings a wealth of experience ideally suited to this newly created position – experience gained both in the outdoor corporate arena as well as from the field.

As COO, Bard will assemble a national sales rep force while managing Ortovox USA's distribution network. Additionally, he will work to increase sales of Ortovox backpacks and Merino wool softgoods – building upon Ortovox's leading position in avalanche transceivers, shovels and probes.

For more information on Dale Bard or on the Ortovox family of products, contact Marcus Peterson at 603-746-3176 or ortovoxusa@aol.com. Currently Dale Bard may be reached at dalebard@msn.com. ❄️

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Backcountry Access Arsenal Shovel

Review by Mike Alkaitis

Backcountry Access (BCA) is continually updating their shovels, probes, and saws to make your backcountry skiing adventure more enjoyable. This year they have redesigned their integrated shovel and probe system (the probe fits inside the shovel shaft) and expanded the idea to an integrated snow saw (the saw now also fits in the shaft). The innovative part of the Arsenal system is its "nested" grip, which enables the user to remove the probe or saw from the shaft without dismantling the shovel. After removal, the shovel remains intact and fully functional for rescue or snow study.

Both shovels are all aluminum, feature BCA's bomber oval shaft design, and create a nice balance of weight and durability. We used the Arsenal shovel systems on winter climbs of Longs Peak and numerous backcountry ski outings along the Front Range and other Colorado locations.

The shovel blades held up to digging camps and snowpits without showing signs of cracking or weakening.

The Arsenal shovel with 240 probe weighs in at 27 ounces with the Tour blade and 30 ounces with the Companion blade. We tested this model with the Tour blade. At 240cm, the probe is longer and sturdier than BCA's existing integrated 180cm Tour probe. It is easy to use and only takes a bit of practice to get the probe broken down and back into the shaft. Its push-pin tensioning system is faster than the twistlock system on the Tour probe and has a cable adjustment mechanism. The Arsenal saw can be purchased separately and stowed in the shaft in lieu of the probe, but not vice versa. Overall the Arsenal is a great option for those looking to save space in their pack for things like a Thermos of hot coffee.

The Arsenal shovel with 35cm saw and extendable Companion blade (also comes with the Tour blade) was a hit with the avalanche instructors and those creating snow blocks to set up camp. It comes with a small plastic sheath. The saw is easy to remove and replace in the shaft and is an excellent way to not have a sharp saw roaming around inside your pack.

These two new integrated shovels are a nice addition to anyone looking to upgrade their shovel, probe, and/or saw system. Check out www.backcountryaccess.com/Arsenal for details.

Mike Alkaitis is the general manager of the Colorado Mountain School (CMS), a full-service climbing and backcountry skiing guide service based in Estes Park. He is also a senior guide for CMS and an AMGA-certified rock guide who works in the ski, alpine, and rock disciplines. ❄️



Backcountry Access Signs Sponsorship Agreement with National Ski Patrol

Backcountry Access (BCA) has signed a sponsorship agreement with the National Ski Patrol (NSP). BCA's partnership with the NSP will be education-focused; the company plans to support a rewrite of the NSP *Avalanche Fundamentals* textbook. The new textbook is slated for release the beginning of the 2009/10 season. NSP members will also be eligible for a discount on BCA products, including the much-anticipated Tracker2 beacon and Float 30 avalanche airbag, which will be released in fall 2009. ❄️



Are you Beeping?

An avalanche beacon isn't going to do anybody any good unless it's turned on. That's why Backcountry Access, Inc. (BCA) is offering its new Beacon Checker. The device can be installed at patrol rooms, backcountry access gates, alpine huts, and other egress points to ensure that your beacon is turned on and transmitting properly.

The device was successfully tested last season at several resorts including Silverton Mountain, Sunshine Village, and Jackson Hole Mountain Resort. It is about 5" square and shows a red "X" or a green "O," depending on whether the closest person's beacon is transmitting. It has a series of switches for controlling volume, brightness, lowering battery consumption, and adding external devices such as a mechanical latch. It comes with a power converter so can run off a variety of power sources including 110 and 12-volt systems.

For pro and fleet pricing on Beacon Checkers, Beacon Training Parks, Tracker DTS, and other avalanche safety equipment, contact BCA at info@backcountryaccess.com or go to the Pro Services page on the BCA Web site. ❄️

aaa news**American Avalanche Association Spring Board Meeting Highlights**

The American Avalanche Association (AAA) Governing Board spring meeting was held in Frisco, Colorado, on April 24, 2009. In attendance were 12 board members and section representatives and three members.

President and Vice President's Remarks

President Janet Kellam welcomed the group and thanked them for their attendance and participation. She reminded those present that the AAA considers three guidelines when making business decisions: is the decision operationally feasible, is it fiscally sound, and is it sustainable? Vice President Doug Richmond noted that the AAA is always looking for new and better ways to operate and govern and invites suggestions and feedback from all members.

Treasurer's Report, Bill Glude

Bill noted that the AAA is at its usual financial level for this time of year, with over \$37,000 in the operating account. He expressed concern that typical donations to the AAA are likely to lessen as the economy suffers. Even so, the AAA is doing a good job of balancing income against expenses, providing a range of member services, and remaining within budgetary constraints.

The AVPRO courses made money for the first time this past season, and it can be expected to generate revenue as it becomes a standard in advanced avalanche education.

The budget breakdown shows the major income categories in round figures as AVPRO at \$37,500; dues at \$28,500; donations at \$13,000; *The Avalanche Review* (TAR) advertising \$11,000; donations \$10,000; sales (SWAG, logo merchandise) at \$8000. All other categories of income are approximately \$2000 each.

Major expenses in round figures are \$25,000 for AVPRO; \$23,000 for TAR production and staff; \$13,500 for our executive director; \$6000 for procuring merchandise; \$5000 operating expenses, \$3000 for the membership directory; and \$2600 for travel and meeting expenses. All other expense categories were all under \$2000 each. Bill also noted that for this and the next fiscal years, web and IT development costs would rise as necessary infrastructure is put in place and the AAA Web build out is completed.

Bill noted that membership dues increased as of November 1, 2008, and he hoped that the dues increase would offset a likely decrease in revenue streams.

Executive Director's Report, Mark Mueller

Mark stated that the AAA's endowment had decreased in value due to the current economic climate and it was likely to decrease further.

There is one large upcoming expense: the printing of the SWAG second edition. A purchase of 1,200 copies is being considered as printing in bulk reduces production costs. It's hoped that the cost to members will remain constant, but that depends on production costs. As well, there are a number of expected new users of the SWAG 2nd edition – the National Avalanche School and avalanche education providers among them.

The current AAA membership roll consists of approximately 1,100 members, which increases a bit each year. Mark noted that the AAA membership is a dynamic demographic, and reaching members via a postal address is sometimes difficult.

COMMITTEE REPORTS**Research, Ethan Greene for HP Marshall**

Only one proposal for research funding was received: a practitioner's grant request from Theo Meiners (Alaska Rendezvous Heli-Guides) and Kelly Elder (USFS). Theo proposes to examine the veracity and usefulness of stability tests on slopes steeper than 40°. Funding of \$1,500 was approved.

Ethan noted that it would be nice to receive more proposals so as to have competition for grant awards.

Publications, Blase Reardon

Blase began by noting that TAR accounts for approximately 25% of all AAA operating expenses,

and approximately 40% of these costs are recovered through advertising revenue.

TAR editor Lynne Wolfe asked for, and was granted, the option to increase TAR's content from 28 to 32 pages, on a per-issue basis, as publication submissions dictate. Recent previous issues of TAR were printed at 32 pages and were well received.

Education, Sarah Carpenter & Brad Sawtell

Brad suggested a change to the AAA's mission statement to more accurately reflect and describe what the AAA does, in particular with respect to creating avalanche-education course guidelines and AVPRO. A revised mission statement was suggested and approved: *To provide for, promote, and support avalanche education in the US.*

AVPRO realized a \$10,000 profit during the past season from two courses, one each in Montana and Colorado. Feedback from students indicated that they felt the courses were very appropriate for ski area operational staff. For the upcoming season, two courses are proposed: one in Utah's Little Cottonwood Canyon and one in Colorado, at Breckenridge or Telluride. The Colorado course may experiment as a "traveling course," visiting various locations within the state. Sarah and Brad are working with the AMGA to recognize AVPRO courses as meeting requirements for the avalanche course portion of ski-guide certification.

Lastly, the Education Committee was tasked to create a proposal for the Fall 2009 board meeting on how to best implement a continuing education requirement for the Certified Instructor program.

Awards, Halsted Morris

Halsted asked that the name of the committee be changed to Awards and Memorial Committee; the change was approved.

Halsted proposed that, and received approval for, Andrew "Drew" J Entin, a patroller as Squaw Valley who perished while working a control route on March 3, 2009, be added to the Memorial List.

Search and Rescue**Halsted Morris for Dale Atkins**

Dale has been very busy providing an AAA presence at various gatherings, including annual Mountain Rescue Association meetings, both AVPRO courses, and the International Commission for Alpine Rescue (IKAR). He noted that the IKAR is working toward standardizing terms for the four phases of an avalanche search. Dale noted that AAA members should look for an avalanche dog survey from the IKAR sometime in the fall of 2009.

Ski Areas, Bill Williamson

Bill made a presentation to the International Society of Explosives Engineers, reported in TAR 27/4. He shared data on types of delivery systems used at ski areas in the US. He also discussed this data with the National Ski Areas Association (NSAA). He noted that there is a fair amount of concern about the amount of explosives used and their delivery methods.

Bill stated there has been quite a bit of formal and informal discussion of what the AAA's role should be regarding the unusually high number of in-area avalanche-related deaths this season. Ethan mentioned that this would be a good opportunity for the AAA to use these unfortunate incidents to promote awareness of avalanche hazard and not the incidents themselves.

Membership, Stuart Thompson

All applicants for member affiliate status were approved unanimously.

Merchandising, Mark Mueller for Lel Tone

AAA logo items are available online via the www.backcountry.net online store.

SECTION REPRESENTATIVES**Rockies, John Brennan**

John noted that he's been in contact with snowmobile clubs in the Rockies section in an effort to entice both



AAA publications chair and former TAR editor Blase Reardon enjoys the party at the Loveland Pass spring corn harvest.

Photo by Rick Grubin

subscribers and member affiliate applicants. He sent copies of TAR to these clubs as a means to pursue this.

Alaska, Carl Skustad

Carl noted there were, to date, three avalanche-related fatalities in Alaska this season: two snowmobilers and one heli skier.

Tom Mattice has been hired by the City and Borough of Juneau to direct avalanche-mitigation work. Most of Mr. Mattice's work had been done for Juneau's power company, which lost towers in the Snettisham power line corridor after a late spring avalanche.

Lastly, Carl mentioned that the ISSW 2012 would likely be held in Anchorage.

Northwest, Patty Morrison

Patty noted that, due to abnormal NW weather and snowpack, to date, there had been two avalanche deaths: one from a roof slide and the other a snowmobiler.

Lastly, Patty stated that the Northwest Avalanche Center (NWAC) was experiencing financial difficulties, and was working diligently to replace lost funding that is no longer provided by the USFS.

Member Affiliate, Rick Grubin

Rick asked for a list of member affiliates whose membership had lapsed so he could contact them, if possible, and discuss renewal options. Rick also asked for a list of new member affiliates, so he could send them a welcome note from the AAA.

NEW BUSINESS**Business Support, Mark Mueller**

Mark advised CIL/Orion that their annual donation is spent on both education and research, some of which is explosives related, but not exclusively so. Bill Williamson will speak with CIL/Orion and be clear with the respective parties as to what the AAA's priorities are and let CIL/Orion know more specifically how donated funds are spent.

Data, currently vacant

This committee chair is largely replaced by the Web/IT committee chair. Discussion was held as to merging it with Web/IT; it was decided to hold the committee chair vacant and search for a replacement. It was also agreed that the AAA would help find ways to restart the Worldwide Avalanche Network (WWAN) service.

Certified Instructor Program

Brad Sawtell was approved as the new chair of this committee, and its function was moved under the Education Committee.

Continued on next page ➤

AAA SPRING BOARD MEETING

continued from previous page



CAIC staffers Ethan Greene (standing), Spencer Logan, and Brad Sawtell celebrate the good turnout at the Loveland Corn Harvest in April.

Photo by Rick Grubin

FUNDING AND GRANTS

Continuing Education

Three separate requests for funding were identified: the National Avalanche Center annual meeting in October, the annual Colorado Snow and Avalanche Workshop in October, and the 2009 Northwest Snow and Avalanche Summit in October.

It was decided that requests for grants must include a statement of purpose as to how the requested funds are to be used, a description of the intended audience, a listing of potential and known partners for the event, and a budget for the event in question. The AAA board will review all funding requests prior to granting funds.

ISSW 2009, Davos Switzerland

The AAA will fund Executive Director Mark Mueller's airfare in order for him to represent the AAA at the ISSW 2009.

National Avalanche School

It was suggested that some funds be donated to the National Avalanche School for its upcoming annual course offering

Web / IT, Janet for Chris Lundy

The Web/IT upgrade is approximately \$500 over budget, primarily due to the need for more back-end programming. The programming staff had already donated over \$1000 of work to make up for the shortfall. The budget for front-end design was approximately \$100 over budget. In total, the redesign work has cost approximately \$4000 to date, with an expected total cost of approximately \$5,500, including donated time and materials.

The transfer of the avalanche.org web domain and its associated assets to the AAA is underway.

Awards Memorial Committee Update

At the spring 2009 board of directors meeting the name of the Awards Committee was changed to the Awards and Memorial Committee.

Also at the spring board meeting, Halsted Morris proposed adding Andrew "Drew" J Entin to the AAA's Memorial list. Andrew Entin died as the result of injuries he sustained in an avalanche while doing mitigation work at Squaw Valley on March 2009. The board approved the addition of Drew to the memorial list.

There are now 50 people listed on the AAA Memorial list. These are people who were killed on the clock while engaged in avalanche-related work. The memorial list starts in 1944. Currently there are 21 ski patrollers, 13 highway technicians, three USFS snow rangers, three avalanche forecasters, two avalanche gunners, two climbing guides, two heliski guides, one railroad technician, one search and rescue team member, one snowcat ski guide, and one ski area trail crew member on the list.

The Awards and Memorial Committee hopes to have the memorial list posted on the AAA Web site this fall.

New Pro Members:

Greg French, Mt. Charleston, NV
 Wesley Reynolds, Aspen, CO
 Dudley Improta, Missoula, MT
 Gail Bindner, Salida, CO
 Scott Pressly, Salida, CO
 Stephen Charest, Jericho, VT
 Andrew Ryan, Driggs, ID
 Geoff Unger, Moab, UT
 Kim Grant, Telluride, CO
 Charla Whiting, Joseph, OR
 Erik Sweet, San Martin de los Andes, Argentina
 Larry Goldie, Winthrop, WA
 Sara Lundy, Ketchum, ID
 Santiago Rodriguez, Boise, ID
 Peter Earle, Park City, UT
 Matthew Wieland, Bozeman, MT
 Jeffrey Edelson, Snowmass Village, CO
 Brian Newman, Eldora, CO
 Hawk Ferenczy, Pinedale, WY
 David Weber, Lander, WY
 Tino Villanueva, Seattle, WA
 Chris Mohr, Big Sky, MT
 Brad Whiting, Wenatchee, WA
 Irene Henninger, Big Sky, MT
 Rachel Moscarella, Arroyo Seco, NM
 John Thomson, Seattle, WA
 Chris DeVito, Dillon, CO
 Eric Bader, Boulder, CO
 Brad E Carpenter, Gallatin Gateway, MT
 Christopher Barnes, Leadville, CO
 Jaime Pollette, Bethlehem, NH
 Aaron Opp, Ellensburg, WA
 Seth Carboni, Hungry Horse, MT
 Hoots Witsoe, Cordova, AK
 Krista Hildebrandt, Crested Butte, CO
 Josh Feinberg, Mammoth Lakes, CA
 Mark Frankman, Telluride, CO

New Member Affiliates:

David Kelly, Bozeman, MT
 Winthrop C. Allen, Salt Lake City, UT
 David Patterson, Beaverton, OR
 Michael Walenta, Grand Rapids, MI
 Reid Cross, Chico, CA
 Joel Williams, Grand Junction, CO
 Taylor Bones, Bloomfield, MI
 Johnny McKinnon, Crested Butte, CO
 Christopher Wright, Bend, OR
 Ben Adkison, Whitehall, MT
 Paul Terwilliger, Henniker, NH
 Zach Guy, Jackson, WY
 John Bressette, Juneau, AK
 Clark Corey, Stanley, ID
 David Dellamora, Dillon, CO
 Keith Potts, Mt. Shasta, CA
 David Riggs, Truckee, CA

New Certified Instructors:

Mark E. Fisher, West Jordan, UT
 Marc Beverly, Albuquerque, NM
 Tom Mattice, Juneau, AK
 Ken Bokelund, Truckee, CA
 Andy Gleason, Durango, CO
 Tom Leonard, Big Sky, MT
 Mike Cooperstein, Bozeman, MT
 Tim Farrar, Reno, NV

AAA Takes Reins at Avalanche.org

Dear Avalanche Community:

Many of you noticed the new look of www.avalanche.org last winter. The American Avalanche Association partnered with WWAN and avalanche.org to give the Web site a fresh look so it could maintain its position as the leading avalanche Web site for the American avalanche community. That's in large part due to the tireless efforts of Dan (Judd) and Howie (Dan Howlett) – the visionaries, brains, and laborers behind avalanche.org since its inception in 1996. These two deserve an enormous amount of thanks for creating this US avalanche network and for the thousands of hours they've poured into it since then.

This summer, AAA has again been working closely with avalanche.org. That's in part because the AAA and avalanche.org share common goals: uniting the professional avalanche community, advancing the profession, facilitating professional opportunities, and helping reach the general public and professionals with avalanche information. But that collaboration is also occurring because Dan & Howie are transferring www.avalanche.org along with some infrastructure and support to the AAA for future management and development. I don't know how else to profile this exchange, except to say it is a big gift and a big deal. In 1996, AAA simply did not have the resources or the IT abilities to develop anything like avalanche.org. Now we are all able to benefit from the transfer of this internationally recognized platform and take it into the future.

I'd like to review avalanche.org's mission and some of its functions. Avalanche.org is a nonprofit designed and maintained for the benefit of the professional avalanche community, and the AAA will continue this mission. Avalanche.org currently:

- Maintains links to and/or hosts US avalanche center information and their advisories. Avalanche advisories are utilized daily by professionals and the public. Avalanche.org operates in a "mission critical" manner and maintains a back up server in order to guarantee this information is available 24/7.
- Compiles US Accident reports in partnership with the CAIC. News links are provided immediately upon release, but these are followed by reports which are researched and validated by local avalanche centers. These reports provide the most current and accurate information possible, information that's essential in today's world of sometimes misleading or inaccurate blogs.
- Posts employment notices when submitted to the webmaster
- Provides a searchable database – by name or state – for education providers who are AAA professional members.
- Provides a searchable database of AAA professional members, which is a valuable resource for employers and members alike.
- Maintains links to several key professional sites such as the AAA Web site (currently being updated and redesigned to better mesh with avalanche.org). This includes valuable reference resources such as archives of *The Avalanche Review*, proceedings from past ISSWs, information on the upcoming ISSWs, and the National Avalanche Center tech pages and avalanche tutorial.

Note: If you are a current or former WWAN member, please hang in there with us. Some components of Westwide Avalanche Network have fallen out of use, such as the Powder Cloud Times (professional chat room) and Avalanche Notes (US ski area snow and weather data). We are not discarding those programs, but give us a little time. Once we get a handle on all the behind-the-scenes operations, we will ask you for ideas about network and data programs. Be thinking about what might work for you now and into the future. Our goal is for avalanche.org services to make your job easier. When all of the avalanche community participates, we all benefit.

To maintain these functions, a small AAA-IT working group will continually update the Web site as pertinent material comes in. This is material such as accident reports, employment advertisements, educational and member information. In addition, this IT group will manage databases behind the scenes and begin to implement a variety of new and desirable programs. The work group has already put in large amounts of time, with only some of the hours and duties getting paid. It is essential that avalanche.org generate enough annual income to guarantee quality, consistency, and professional services. Although avalanche.org will benefit from AAA oversight, all avalanche.org income will be used only for maintenance and development of avalanche.org services and will reside in its own separate fund.

Follow our progress as we develop products for the professional community. Please contribute. Check your current member contact information in the printed directory and your basic information on the Web site. Send us your updated e-mail and AAA member directory information through the contact links. We do not release any of your personal information, but we may forward onto you professional offers from various companies; we need your e-mail to do this.

Avalanche.org provides a unified and professional guarantee of information and products. If a single professional group did not provide a network like avalanche.org, it would be very difficult to consistently locate and utilize current and accurate US avalanche information, services, and databases.

Thanks for your participation,

—Janet Kellam, president, American Avalanche Association ❄️

snow science

Beetles and Avalanche Risk

Story by Frank Davis

For a number of years, western North America has been experiencing an increasingly virulent bark beetle epidemic among its mature lodgepole pine forests. This article suggests that the long-term effects of the infestation are important for the assessment of terrain-related avalanche risks.

Anecdotally, several years ago, while driving toward Silverthorne, Colorado, a large number of dying red-forested hills caught my attention. Recognizing the red discoloration as an indicator of the bark beetle epidemic, the scale of the destruction was both impressive and disturbing. Later in the fall of 2007, the severity of the epidemic was further indicated when the Medicine Bow / Routt National Forests published a pamphlet titled, *What's Eating the Trees?* Included was a figure from a 2006 aerial survey displaying the extent of the bark beetle infestation for these two forests.

The pamphlet argued that the infestation was increasing and implied that most lodgepole pine forests could expect to experience the epidemic in the future. The suggested wide-scale forest destruction becomes more impressive when considering that as of January 2009, the Forest Service estimated more than 3-million acres had been affected in just Colorado and Wyoming.

In the early infestation stages, visual detection of an infected forest is difficult. By the time a forest turns red, such as those around Silverthorne, it's too late to save it. Months after the needles turn red, they begin turning brown and eventually fall to the ground, leaving a forest of large, standing toothpicks. A number of years later these too will fall to the ground.

Having recognized the infestation problem, it's reasonable to ask, "Of what possible concern is a beetle-killed tree to me while skiing or boarding?" In response, visualize an extensive lodgepole forested slope where you frequently ski or board. Ask yourself how a beetle infestation could affect the condition of the slope. A quick answer suggests at least four effects that may influence avalanche risk evaluation.

- 1. Forest protection:** A dense lodgepole forest that recently died and lost its needles will have more open slopes. Common route-selection procedures use forest protection as part of their methodology. With the beetle kill loss of forest density, travelers will be exposed to an increased risk of avalanches running through the stark, standing trunk spars.
- 2. Forest slope stabilization:** The loss of needles and small branches means a significantly reduced capability for catching snow and stabilizing the

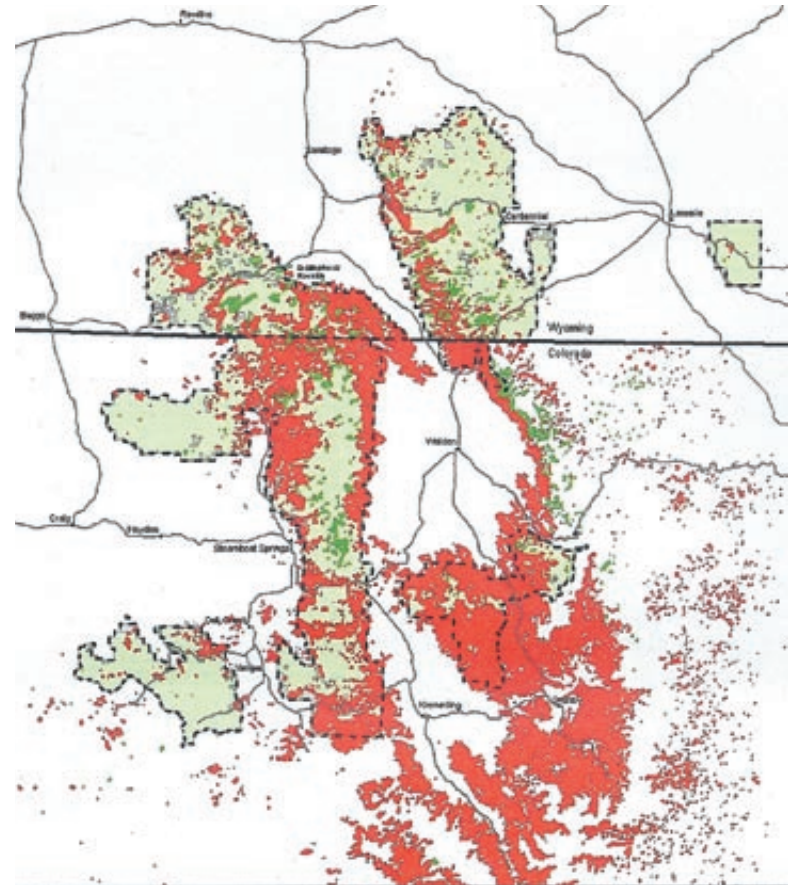
snowpack. The result: a decrease in slab anchoring by the forest.

- 3. Wind loading changes:** As forest density diminishes, the slopes will experience a change in the patterns of cross-slope wind loading, again increasing avalanche risk.
- 4. Unseen fallen forest trunk hazard:** More open slopes are attractive to the early season skier. Assume a shallow early season snowpack with fallen logs hidden just beneath the snow surface. It is possible for skiers to punch through to the logs beneath the snow surface. Responding to trauma incidents would expose rescuers to avalanche risk.

If you have seen or are likely to see any of these effects, it is time to question what you can do to reduce the potential consequences of the risk factors.

Bruce Tremper and others have been emphasizing the importance of human factors in decision-making while assessing avalanche risk. One difficulty they point out is we tend to accept the familiar without question. For example, when looking at a familiar slope that has experienced beetle kill, it would be a mistake to evaluate the risks as if the slope were unchanged. The alternative approach should be to question the risks as if the slopes were unfamiliar. It is likely that the risk factors may be reduced when considering personal human factor responses by making decisions based upon what is observed, not what is familiar.

With this in mind, the problem of reducing the risk factors becomes a problem of modifying your personal human behavior. Recognizing the presence of one or more risk factors and appealing to reason is not enough. The history of avalanche education has shown that logical recognition of risk factors does not offer assurance that the information will be included in the personal habitual decision processes. Rather, the individual must work to assimilate observations into the internalized thought processes. This is the hard part. The processes are part of our unconscious habitual thinking and decision-making. Rarely can the process of adjustment be made only once. Rather, it must become part of habitually practiced safe-travel rituals. Only when done repeatedly will the modification become



Medicine Bow & Routt National Forests Bark Beetles from 2006 Aerial Survey



part of the unconscious thought processes.

A simple take to the field message: Resist the urge to compare the slope with the way it used to be. Remember, making a decision based upon the familiar is a human-factor trap. The time for nostalgia is at the end-of-the-day party, not when you are studying the slope with the intent of picking a safe travel route. By doing this, the risk factors can be reduced. You will again be able to experience the fun and challenges of what will become the exploration of a new slope.

A concluding word of caution: if the forested slopes you plan to visit are not lodgepole pine, there may still be similar beetle-created avalanche hazards. Some examples: Spruce beetles (Englemann spruce forests in the San Juan Mountains of southern Colorado), Ips beetle, western balsam bark beetle, and Douglas fir beetle may also create a hazard. Observe the condition of the forest. Know your realistic interpretative strengths and weaknesses. Make route-selection decisions in terms of your own personal human factors.

Frank Davis is an avalanche instructor with the Snowy Range Ski Patrol in Wyoming. He is a past director of the Rocky Mountain Division, National Ski Patrol. ❄️

How Big a Player is TRAUMA in Avalanche Fatalities?

Research and commentary review by Nick Armitage

Patterns of death among avalanche fatalities: a 21-year review. Jeff Boyd, MBBS, Pascal Haegeli, PhD, Riyad B. Abu-Laban, MD MHSc, Michael Shuster, MD and John C. Butt, MD CM <http://www.cmaj.ca/cgi/content/full/180/5/507>

Should strategies for care of avalanche victims change? Hermann Brugger, MD <http://www.cmaj.ca/cgi/content/full/180/5/491>

In the first study, Boyd and colleagues research all of the avalanche deaths in Alberta and B.C. between 1984 and 2005. They found 204 cases with mortality information, 117 of which underwent autopsy and 87 received forensic external examinations. The findings of their study have implications on rescue, research, and education, as well as the future of safety equipment.

As Brugger points out in his commentary, an "unexpectedly high rate of trauma ... raises a number of questions." Some of the noteworthy results were the overall high rate of trauma related mortality (24%), with 30% among heli-skiers and as high as 33% for out-of-bounds skiers. This work by Boyd sheds more light on trauma as a higher risk factor for several user groups than previously thought within western Canada. Boyd also points out the significant (almost 20%) variations of data between western Canada and some US/Europe figures on trauma fatalities, which begs for more analysis of past and future incidents worldwide. In order to look more deeply into the different types of trauma, the study also calculated a trauma-severity score for all autopsy subjects. Interestingly enough, they found that the chest (46%) and head (42%) ranked first and second in cases with single-system trauma, while the neck only accounted for 8% of these cases. Following more research, this information could lead protective equipment development in a different direction.

The depth of this research also has numbers on victims who were provided with CPR and pre-hospital ALS. It goes as far as discussing equipment used or not used by victims including one of 13 ice climbers wearing a transceiver. Boyd and his colleagues discuss figures on the interplay of trauma and asphyxiation. They found that "13% of asphyxia victims who underwent autopsy had major trauma," as defined by their injury-severity score. In other words, did the trauma play a role in hastening the asphyxiation? With the details of this trauma/asphyxiation relationship and the great difference in trauma-related mortality by region (country), is a reevaluation of past data and current practices warranted?

As Brugger's commentary is entitled, *Should strategies for care of avalanche victims change?* Should rescue organizations expand their window before assuming they are involved in a recovery operation? Does organized rescue have a better chance at saving lives? Are differences in geography and user groups enough to account for this data's heavier lean towards trauma as a cause of avalanche deaths? For instance: Is the terrain of the Wasatch so different from the mountains of western Canada to account for almost 20% fewer trauma-caused deaths? To ponder possible answers and perhaps raise more questions check out the above links to the Canadian Medical Association.

Nick Armitage has been assistant snow safety manager and avalanche forecaster at Big Sky Resort for the past four seasons. In the summer he is the newest Jenny Lake climbing ranger. He is also a BCA tech rep and has a BS in mechanical engineering from Colorado State University. ❄️



Snow Geeks Storm Alaska

Story by Alex Meiners • Photos by Karl Birkeland

Three in the afternoon had come and gone and still the helicopter was sitting on the heli deck.

Five hours had passed since a radio call had come in from the Alaska Rendezvous Guides and snow scientists Ethan Greene and HP Marshall. The cold temps meant that the blow-dryer might have to be plugged in to defrost the main rotor blades before the group of six could be picked up in the field.

There is an old lament one may hear about Valdez, going back to the early days of heli-skiing in the Chugach from the 1990s and Doug Coombs: "Things aren't what they used to be." Guides used to take clients down more serious faces more often, snowpits and snow-study plots were hardly used, and the Chugach was only for the hard core where biplanes and a couple of helicopters were the single mode of skiing transportation.

This is not entirely true. Big lines still get skied; snowpits on every face of every angle aren't always dug; and yes, the Chugach is still for the hard core. Planes may not be used anymore, but A-Star helicopters are as common as K2 skis.

However, there has been a change over the last few years in the area of Thompson Pass. Not only are there more companies skiing the same region, and the draw to the area has become greater, but there is now a group of scientists working with Alaska Rendezvous Heli-Guides (ARG) to improve our understanding of south-central Alaskan snow and snow science in general.

Karl Birkeland, Kelly Elder, Ethan Greene, HP Marshall, and Doug Abromeit have joined forces with Theo Meiners, owner of ARG, in developing a snow-science program in Alaska. This program gives these scientists the ability to work with the guides of ARG in the field in an applicable manner while also furthering their own studies in snow science within their areas of expertise.



Sam Sehnert gears up in a 47 degree pit on Cauliflower 1.

radar mapping snow depths and snow stratigraphy via helicopter

HP Marshall is modifying his ground-based FMCW radar for use on a helicopter, with the goal of developing a technique for mapping snow depth and stratigraphy in starting zones. This would provide guides with information about the slope without stepping outside the helicopter. While estimating snow strength from radar is unlikely to be accurate enough for use by practitioners, the radar can accurately measure the other half of the stability equation – estimates of the weight of the snow (the snow water equivalent) can be made by timing the radar signal through the snowpack. Marshall has been funded to develop these radars for remote sensing applications in snow hydrology (NASA) and for land-mine detection (CRREL).

field-stability tests on the high end of the slope-angle range

Karl Birkeland is studying field-stability tests on steep slopes with angles of 40-50 degrees. While many stability studies have been performed on slopes with angles from 25-40 degrees, very few experiments have been systematically performed on steeper slopes, and no studies of fracture propagation have ever focused on these steep angles. The Chugach provides a unique environment where steep slopes are accessible and

regularly skied, providing an opportunity to test field stability tests at the high end of the slope-angle range.

snow layers and microstructure development on the steeps

Ethan Greene, who forecasted in the Salt Lake City area (including for the Olympics) and now works in Colorado, is trying to characterize snow from a research perspective and identify how snow layers develop in very steep terrain.

He became involved with the ARG team after meeting Marshall when they were both graduate students in Colorado. Greene is interested in the microstructure of the snow that develops through metamorphism and its affect on avalanche formation.

studying snow morphology in a singular microclimate

Kelly Elder's interests range from the morphology of snow crystals to the distribution and character of snow on the basin scale. In the lower 48 states, snow climates vary on the scale of 10 to 1000km, but similar transitions may occur over much smaller distances in the Chugach range where maritime, arctic, and continental climates all collide in a small region. Elder and other members of the group are interested in the variation of meteorology and snow characteristics in this data-sparse region.

Elder is also exploring field methods for observing snow morphology. He has designed and built a portable microscope that can be used to photograph snow crystals and document the crystal structure created by metamorphism in the northern climates.

observing guide-client interactions and decision-making

This year, Doug Abromeit joined Karl as an observer to see how guides interact with the public, their clients, and how, as an educator, the decision is made to go or not to go.

This last winter Marshall and Greene helped develop three snow study plots close to ARG's base. The scientists and ARG staff built snow stakes that could be read by guides as they traveled on the ground or as they passed a site in a helicopter. The guides provided local knowledge of the terrain to select areas with both an operational and scientific significance. Throughout the operational season the guides collected data at these sites. The data helped the guides track temporal changes in the snowpack and will also help the scientists understand the dramatic spatial changes that occur in the Chugach.



above: Refrozen drainage channel from January rain even on Crybabies.

left: Kim Grant examines the ash layer from the eruption of Mt Redoubt.

Eventually the scientists and ARG would like to have 10 snow study plots at different aspects, elevations, and zones within the operational area to understand the developing snowpack in the area and give a quantitative measure of storm snow.

By using snow stakes and finding good snow-study plots, they are working towards establishing permanent automated weather station locations that would relay information to the base, bring in more information about the snow, and help answer specific research questions for this remote location.

"This is the poor man's first step towards weather stations," Marshall said.

While the Swiss have millions of dollars allocated to the science of avalanche and snow, the United States has little money, because not many people live in avalanche terrain. "As more and more people become involved with snow and the development of snow science, hopefully we will have more money for avalanche research," Marshall said. "Avalanche research is creatively funded out of passion."

In 2007, Karl Birkeland joined Marshall at ARG to work with his new radar concept. During this trip the temps were negative 20, and there was windy hard slab everywhere. Marshall, a professor of geophysics at Boise State University, has been using radar to look at snow depth, snow-water equivalent, and the layering and stratigraphy of the snow. Having worked with radar for several years he is familiar with the tool but has used radar with a helicopter very little, due to the expense. During recon week each year, ARG has generously donated heli time to the project, allowing Marshall to attach the radar to the helicopter's foot in the morning. It runs continuously throughout the day picking up information from the snow.

Now, after three years of working at ARG and many tweaks to the radar, clean snow stratigraphy can be seen in the data – but only when the helicopter is within 50' of the snow surface. Due to the steep Chugach terrain, as the helicopter gets higher in the air, the radar is averaging the signal over larger areas that have significant elevation differences. This makes interpretation of the signal extremely difficult. Marshall is currently working to "focus the radar beam – a bit like changing your flashlight into a laser pointer."

While Marshall has been working with radar, Birkeland has been using more of a shovel-and-snow-saw approach to science. Although he is interested in spatial variability combined with the use and functions of radar, he is trying to make his findings applicable to the average backcountry user. For several seasons he has been making changes on the extended column test, which he has been working on with Ron Simenhois.



Matt Belford looks at snow crystals in Clueland.

Birkeland has been going to ARG since 2007 and is looking at stability tests in steep terrain, between 40 and 50 degrees. He has also been working with Joachim Haerli and Ron Simenhois to collect data to test models of skier triggering.

During Birkeland and Abromeit's April visit, the duo was able to go into an area called Clueland, 13 miles east of the ARG base. This area provides steep and open faces where Birkeland was able to dig several pits and gather information. This area was also able to provide the broader scale of observation of the snowpack Birkeland was using over large areas. Unfortunately, during this time there were not many broad-scale spatial patterns because the snow was exceedingly stable.

During the February visit and the April visit of the snow scientists, ARG hosted two "Science Nights at the Rendezvous" where all other companies and individuals from the area were invited to come and listen to a discussion based on the findings and the direction of science on Thompson Pass. It was an opportunity for the guides in the area to interact and share field data in an applicable manner rather than from a purely scientific approach.

The guides of ARG and the scientists involved do not believe that the information gathered is proprietary – instead it is universal, to be shared with everyone. The ultimate goal is to have a continuing relationship between ARG and the science community and to have a scientific presence during the whole season.

Alexandra Meiners was born and raised in the Tetons, which she left for college and various other adventures, including working for a fashion magazine in New York City. Her favorite shoes are high heels and ski boots, and while she may buy milk wearing stilettos, she has currently put non-mountain-functional footwear away in exchange for the mountains of her home and the pursuits of writing and skiing.



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Avalanche Mitigation Services' Variable Payload System (VPS) projectiles utilize technology gleaned from a thorough review of the Avalauncher's development (l-r):

1. Detonating cord is laced into the energy transfer plug (ETS) and through the cast explosives.

2. The energy transfer plug and cast shots is installed into the body of the projectile. The detonating cord lies in contact with the #8 blasting cap.

3. Aerodynamics are improved by wrapping the nose and body/tail interface with quality electric tape.

Avalauncher Developments: VPS Projectiles Reduce Cost While Allowing for Tailored Payloads

Story and photos by John Brennan

The impetus to found Avalanche Mitigation Services (AMS) was a quest to uncover the history of the Avalauncher. Monty Atwater, a leading pioneer of avalanche forecasting and safety in North America and co-developer of the Avalauncher, has always held hero status for me since I cut my teeth on the old blue *Forest Service Avalanche Handbook* several decades ago.

Ironically, I never liked history in school. Maybe the history of some brewery held allure, but even that was short lived. Researching Atwater's involvement in the evolution of the Avalauncher was a labor of love, culminating in a road trip in the spring of 2005 that tied together enough loose ends that I could publish the results of my research in *The Avalanche Review* in February 2006.

At this time I decided to form AMS. The company has both long- and short-range goals. First was to introduce an Avalauncher that was scientifically engineered with a bottom line of user safety. We believe strongly that the true art of engineering surrounds simplicity of design – while it is easy to complicate a design and significantly drive up expense, it was through an intricate understanding of not only the mechanics but also the history of the Avalauncher that the Falcon GT was developed. AMS's founding vision holds a moral liability to our customers as our primary goal, and our contractual insistence on remote firing proves that. Integrity and honesty fall in closely as does our insistence on competitive pricing.

Another founding vision of AMS was to complement our Avalauncher with a Variable Payload System projectile (VPS) using readily available, economical, powerful, and reliable precast explosives. Although AMS had successfully prototyped and demonstrated two unique systems using this approach since our company's inception, with patient perseverance we held off entering the market until we had what we considered to be the elegant solution – a solution using standard industry materials and practices, as confirmed by industry experts and explosive distributors alike.

The Falcon RT VPS projectile uses 12-ounce/ 340-350-gram precast explosives and 50-grain detonation cord. A tried and true Avalanche Control System tail fin provides the launch platform. As opposed to some of our earlier R&D efforts, the current production model leaves the #8 blasting cap in its customary position on top of the tail fin's 209 primer ferrule. The "brains," if you will, of the VPS is a short CNC machined hardwood plug: the ETS (Energy Transfer System). This technology was developed for our first R&D projectile in 2005. The current plug has two holes drilled into it – one is a blind well that partially encapsulates the detonator while a second tunnel hole accepts 50-grain detonator cord. The holes are oriented so that the det cord lies directly in contact with the entire length of the detonator.

The det cord passes through and couples together every explosive in the body of the projectile, so complete and instantaneous detonation of all the precast primers occurs on impact.

As advertised with the 6' tall French Avalauncher projectile, the benefit of having a significant portion of the projectile detonate above the surface of the snow cannot be overstated. As opposed to the quickly attenuating effect of the snowpack on the impact of the explosive blast, which is common in shorter Avalauncher projectiles, air can transmit the avalanche-producing shockwave over a much greater radius of influence. This air-blast effect is most pronounced with our longer projectiles, such as the 48-ounce/1.4kg, 60-ounce/1.7kg, and the 72-ounce/2.1kg versions.

Hans Gubler's ground breaking *Artificial Release of Avalanches by Explosives* states, "The minimal effective range results in a minimum radius of 17-120m for shots above the dry snow cover and of less than 6m for shots in the snow cover." This statement refers to 1kg shots. The article also explains that "...the best efficiency results from charges ignited 1-2m above the snow cover, using explosives with high-detonation velocities."

Hal Hartman, an applied physicist who has spent over three decades dealing with snow-control issues, comments, "Although air blasts are effective triggers, we often overlook, or forget to articulate, the value of detonating explosives in the snowpack. Clearly, detonation results in structural rearrangement of the snowpack which later resists deformation by external loads and serves to interrupt fracture-propagation pathways. For example, quantitative strength measurements of blast craters and the snowpack in close proximity to the blast craters show that the advantageous effects persist for up to 45 days. In economic terms, an explosive 'works' for you around the clock at pennies per day, even while you sleep. So it depends on what strategy is being applied – avalanche release, testing the snowpack for instability, or actively altering snowpack structure."

It's interesting to note that precast explosives were used in the original Avalauncher projectiles and for well over a decade following the system's introduction in the early 1960s. Thousands and thousands of shots have been fired successfully with precast explosives forming the payload of Avalauncher projectiles – nothing new here. The decision to have the projectiles poured directly with explosive material during the mid-1970s was due to simple economics – an explosive manufacturer offered the service for almost the same price as the precast explosives.

The latest VPS projectile was tested with varying payloads (24-, 36- and 48-ounce versions) this spring at Aspen Highlands. Snow Safety Director Peter Carvelli was "very impressed by the design, the ease of assembly, and the shot repeatability during this trial. I like the flexibility of the system, which allows greater or smaller payloads, as I'm a proponent of larger payloads in general. My employers appreciate the significantly lower price point as well, which will allow me to use a greater number of rounds while still keeping within budget [author's note: sub-\$40 total cost to target for 36-ounce version].

"I particularly like the ignition system which is simple, straightforward,

and dependable. Here at the Aspen Highlands we have had an Avalauncher since beginning our expansion into Highland Bowl in 1994. I have been the gunner and mechanic during that time, and as the gun plays a large role in our operation I have a good bit of experience with the various, basic rounds available since 1994: namely the Trojan, Dyno AV 100, and CIL Snowlauncher and Stubby. The AMS round compares very favorably with all of them. This product is definitely worth a try."

Similar testing took place at Arapahoe Basin where Snow Safety Director Leif Borgeson said, "The components are well conceived, professionally prepared, and easily assembled. We fired a handful of the 24-, 36- and 48-ounce rounds out of our Falcon GT gun without issue. The projectiles loaded and launched just like those that we currently buy. Over the years we have used a wide variety of projectiles and this system from John holds the promise of reducing costs and allowing us to tailor our payloads to specific needs. The potential cost reductions will allow us to use more projectiles and still remain within our budget. John Brennan and Avalanche Mitigation Services have always been responsive to our questions. I like his pro-active approach to those who use Avalaunchers."

An ASME-certified design of the AMS Avalauncher is now available in both a standard- and extended-range model (45-liter pressure vessel capacity), and by press time, both versions should be ok'd by WorkSafe BC for sale in British Columbia.

AMS is also pleased to announce the introduction of several other products that address the needs of all Avalauncher owners and explosive users. Pay a visit to the AMS Web site at www.avalanchemitigation.com for all product listings, to see published articles, and to learn more about the company. At AMS, the customers are the main salesmen, and a testimonial section is filled with their comments.

In addition to his work with Avalanche Mitigation Services, John Brennan is the AAA Rockies section representative. ❄️

decision·making

Regional Danger Ratings and the Odds of Triggering a Potentially Fatal Avalanche

Story and photo by Bruce Jamieson

During the small talk before an interview last winter, a reporter said, “They went into the mountains when the avalanche danger was Considerable; they must have known someone would die.” I countered by saying there were hundreds of skiers and snowmobilers who had enjoyed themselves on mountain slopes over the weekend – without being caught in avalanches. This conversation reminded me that, outside the avalanche community, the public understanding is limited about how the Avalanche Danger Scale relates to triggering harmful avalanches. In response, I dusted off an abstract I had submitted and withdrawn twice, asked Jürg Schweizer and Cora Shea to help with parts of the analysis, and submitted the abstract to the 2009 International Snow Science Workshop (ISSW) in Davos. The abstract is called *Simple Calculations of Avalanche Risk for Backcountry Recreation*. The word “simple” is important – I’ll come back to it.

Avalanche risk depends on the probability of an avalanche affecting people (or property) and the expected consequences. For the consequence term in our analysis, we chose to ignore injuries and focus on the probability of death. For any size of avalanche in accident reports, this probability is given in *Avalanche Accidents in Canada 1984-96* on avalanche.ca’s Knowledge Centre. The remaining part of the risk calculation is the probability of being caught. Because upwards of 90% of fatal avalanches are triggered by people, we can focus on the probability of triggering a potentially fatal avalanche.

There are many factors like snowpack conditions, distribution of trigger points, and skilled route selection that could be included in the analysis. Since there are no reliable data for these factors, our risk calculation is thwarted unless we can simplify some and estimate others. We chose to simplify exposure and focus on one factor: the regional danger level since it includes the probability of human triggering (certain, likely, probable, possible, unlikely) and includes something about the distribution of trigger zones (e.g., avoid steeper terrain). (*The US version of the Danger Scale is much clearer about the distribution of trigger zones.*)

The Danger Scale does not specify the exposure associated with the words like possible, probable, etc. Do these probabilities or likelihoods apply to one person exposed to one trigger zone? To one person exposed to multiple trigger zones on a typical run? To multiple ascents and descents by one person in a typical day? To a typical group during a typical day? To all of the groups in the region? Does the exposure assume skilled route selection, or centre-punching start zones, or a typical mixture of the two?

For our estimates of triggering probability, we chose to define one exposure as one person making fresh tracks while directly ascending, traversing or descending a trigger zone without skilled route selection.

So in our search for a simple risk calculation, triggering by the second or third or tenth person in the up-track was ignored. Skilled route selection was excluded partly because the level of skill and its effect on the triggering probability are even more difficult to estimate. We also wanted to establish a baseline, upon which factors like skilled route selection and recognition of local conditions could be later applied.

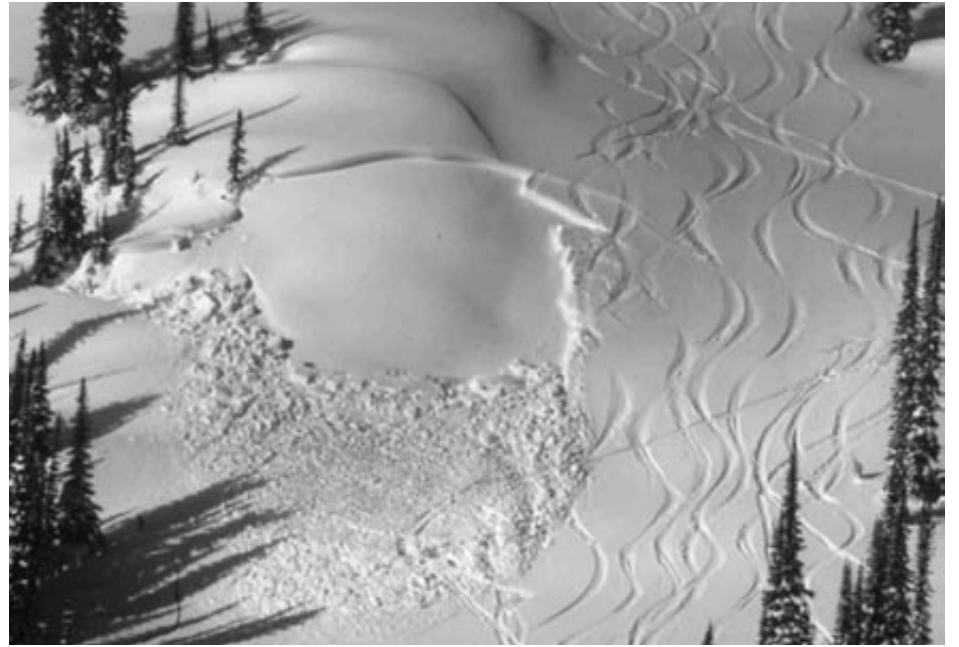
Controversially, we also excluded avalanche size (or consequence) from the triggering probability for a specific level of regional danger because:

- Avalanche size is not explicitly in the danger scale we have used in North America since 1996 (although many skilled regional forecasters probably consider the expected avalanche size or consequence when rating the regional danger).
- We restricted our analysis to potentially fatal avalanches, thus ignoring smaller avalanches.
- We wanted to keep our first risk calculation simple by concentrating on one strong factor, in this case, the regional avalanche danger rating. (*Remember, I had previously withdrawn the abstract twice.*)

Alas, there are no data on the probability or odds of triggering a potentially fatal avalanche in a trigger zone at any level of regional danger. However, in analyses of other risks, such as various types of failures of nuclear power plants, the unknown probabilities are estimated by experts. My first attempt at writing a survey for experts was poor. Fortunately, Pascal Haegeli recommended a book on designing this type of survey (*Morgan and Henrion, 1990*). One of the many good ideas in the book is how to deal with factors which are not in the survey but which some respondents may consider important – like avalanche size in our survey. Respondents are encouraged to estimate the average odds after considering the real variability in unspecified factors.

After many drafts and approval by the University’s Ethics Board, the survey was e-mailed to selected regional forecasters, senior guides, and consultants (experts!) in Canada and the US. Many clearly expressed their concerns about the simplifications behind the survey. For example, two people thought avalanche size should have been explicitly included in the survey, and two thought the same about the area of the forecast region. While the previous paragraphs may partly explain some of the assumptions, I should have expected their reaction to the simplifications: “Reluctance to simplify interpretations” is characteristic of people who are good at managing the unexpected (*Weick and Sutcliffe, 2001*), and that includes avalanche risk.

Twenty-three experts with an average of 28 years experience responded to the survey. This is enough to provide a first look at the expert-estimated odds of a skier triggering a potentially fatal



What are the odds? This slab in the Selkirks was triggered by the eighth person down the slope.

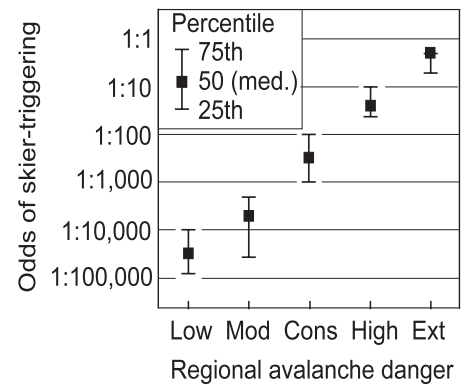
avalanche while making fresh tracks in a single trigger zone without skilled route selection (*see graph at right*).

Sure, there are some strong simplifications. For each rating of regional avalanche danger, the graph shows the median estimate and the range of the middle 50% of estimates. For example, when the avalanche danger is Considerable, the median odds of triggering is 1:300, and 50% of experts estimated the odds of triggering to be between 1:100 and 1:1000. Note that the left axis has a logarithmic scale. The biggest jump (multiplicative increase) in triggering odds is between Moderate and Considerable Danger, and the lowest jump is between Low and Moderate – both of which warrant further analysis.

Although the full range of estimates for any danger level is not shown, it is clear that the uncertainty in the estimates is greater for lower levels of danger. This uncertainty can be due to many sources including: variability in the factors not specified in the survey, ambiguity in the survey, and uncertainty that is inherent to triggering within a forecast region. The final graph of triggering odds as well as the initial simple risk analysis will be presented at the ISSW in Davos in September 2009.

So what? Well, a missing piece of the recreational avalanche-risk puzzle is emerging from the fog. However, I doubt the graph will mean much to the public. Nevertheless, the estimated odds may help those of us who work with avalanches to explain triggering odds and avalanche risk to others. Perhaps the estimated odds can be used to freshen and re-phrase some important messages. For example, the odds of triggering a potentially fatal avalanche can be decreased by:

- skilled route selection (which requires experience),
- seeking out areas or slopes within the forecast region where human triggering of harmful avalanches is less likely, or
- turning around or choosing more cautious routes when signs or clues indicate higher levels of local danger.



For each level of the regional avalanche danger, the graph shows the estimated odds of skier-triggering a potentially fatal avalanche while making fresh tracks in one trigger zone without skilled route selection. The whisker or bar shows the range of the middle 50% of estimates, i.e. from the 25th to the 75th percentile. A square marks the median or 50th percentile.

Acknowledgements

Many thanks to the respondents who completed the difficult survey; to Cora Shea, Jürg Schweizer, Pascal Haegeli and Grant Statham for their advice; and to Kisa Elmer, Cameron Ross, Thomas Exner, Mike Smith, and Mary Clayton for proofreading. For financial support, I am grateful to the Natural Sciences and Engineering Research Council of Canada, HeliCat Canada, the Canadian Avalanche Association, Mike Wiegale Helicopter Skiing, Teck Mining Company, Canada West Ski Areas Association, the Association of Canadian Mountain Guides, Backcountry Lodges of British Columbia, and the Canadian Ski Guides Association.

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Bruce holds the NSERC Research Chair in Snow Avalanche Risk Control at the University of Calgary. He has been puzzling over triggering odds for at least 20 years and finally decided to ask the experts. ❄️

Professional Avalanche Near Misses: Why Do They Happen, Who is Involved, and How Can We Prevent Them?

Story by Ron Simenhois and Scotty Savage

Ned Flanders is caught in a meaty slide in Hairball left... he's on top of the debris; it looks like he's okay.

Most ski patrollers and avalanche professionals have heard a similar radio transmission crackle over the airwaves at some point in their careers. Many have seen peers take big rides or have taken one themselves. Each year, several avalanche professionals experience close calls or “near misses.” Our understanding of snow science has improved dramatically over the years, but complex snowpacks and avalanche conditions occasionally fool even the most seasoned veterans. However, our review of near-miss incidents from a few ski areas showed that decision-making likely plays a greater role in causing professional near misses than unusual snowpack conditions. Our findings echo results from several similar studies and discussions regarding avalanche incidents as a whole.

Decision-making strategies during avalanche mitigation work vary with workers’ experience levels. McCammon provided evidence that people with limited experience in avalanche terrain base their decision-making on simple rules of thumb or “heuristics.” Experienced patrollers likely do not rely on heuristic strategies to the same extent. Instead, they seem to recognize similar situations from past experiences and act accordingly. This process often happens unconsciously and is commonly referred to as an intuition or “gut feeling.” This Recognition Primed Decision (RPD) (Klein 1998) strategy is learned but is difficult to teach in a classroom setting. For individuals with significant experience, RPD generally works well. Patrollers with limited experience lack the requisite experience to effectively employ RPD strategies but likely feel that simple heuristics are too restrictive. These “tweeners” may not realize they are still relatively inexperienced and may falsely recognize the situation they are in.

To reduce decision-making errors, the main challenge is to increase patrollers’ experience levels to the point where they can successfully employ expert decision-making strategies. This is especially important for less experienced individuals. The common factor with all levels of expertise is that humans are fallible; the nature of the decision-making process in the field leaves us susceptible to making mental mistakes.

We analyzed incident reports, interviews, incident debriefs, and personal conversations concerning 33 professional near-miss incidents and identified four major themes that impacted patrollers’ decision-making (figures 1 and 2). First, distractions diverted attention from the avalanche problems staring professionals in the face. Second, patrollers experienced communication breakdowns with their route partners, whether they were 15-year veterans or relative newcomers. Third, avalanche professionals can be goal oriented, ignoring obvious signs in pursuit of objectives. Fourth, ski patrollers can repeat the same mistakes again and again.

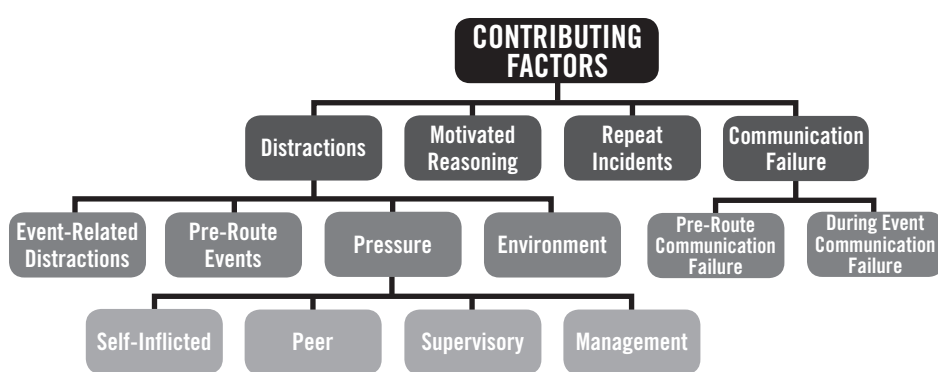


figure 1: Classification tree of contributing factors to decision-making related incidents

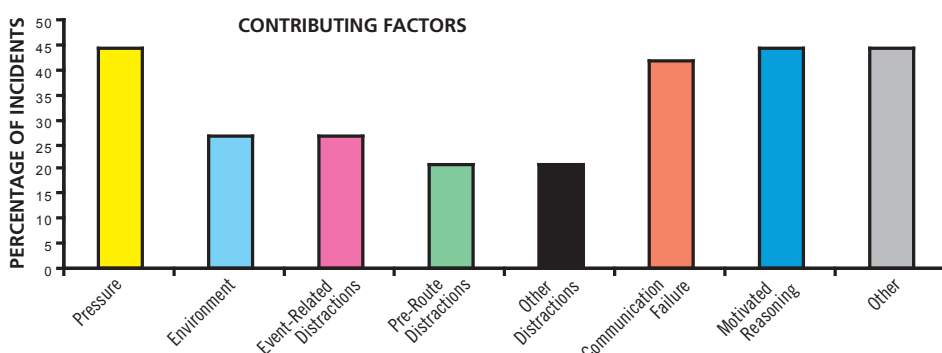


figure 2: Frequency of occurrence for contributing factors in decision-making related near misses

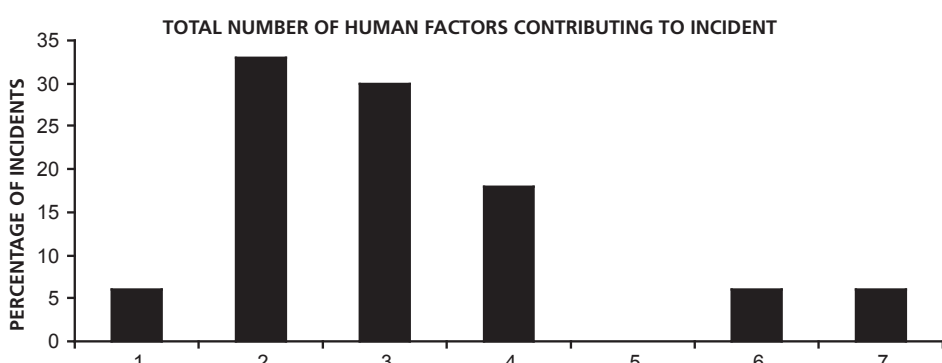


figure 3: Percentage of incidents with multiple human factors contributing to the incident

Most incidents were the result of a combination of these four factors (figure 3) as well as factors that were not evident in the reports and interviews. We will describe the contributing factors of the near misses in our data set and provide suggestions for improving organizational and individual decision making. The following are some of the “characters” who are consistently getting caught.

HEY YOU, PAY ATTENTION

Patrollers were distracted in some way in nearly 80% of the near misses we studied, including an incident involving one of the authors of this article. It’s no surprise that distractions can influence our decision-making. Miller (1956) demonstrated that our conscious brain can only handle about seven pieces of information at any given moment. Cooper and Zheng (2002) looked into effects of cell phone conversations on drivers’ decision-making process as they crossed traffic. They found that the undistracted drivers’ decisions were influenced by their age, the speed of the trailing vehicle, the level of indecision, and the condition of the track surface. However, when distracted, drivers did not factor the pavement surface condition into the decision-making process. On wet pavement, drivers caused collisions twice as frequently when distracted as when not distracted. Distractions load our brains with irrelevant information. This may result in a failure to consider important information or recognize patterns, or it could allow a more emotional part of the brain to take over the decision-making process. We observed several significant distractions that appear to dramatically affect patrollers.

In 34% of the incidents, patrollers were significantly distracted before leaving the locker room to go to work. This included domestic-partner disputes and grievances with coworkers and supervisors. In two cases, patrollers reported that they were distracted by thoughts about another patroller who was injured earlier in the day. This suggests an interesting case where patroller injury can indirectly cause injuries to other patrollers.

In 45% of the cases, pressure from management, supervisors, peers, and self contributed to the incident. Although most ski-area managers do not directly pressure ski patrollers, most avalanche professionals place a lot of stress on themselves to perform at a high level. This perceived pressure fosters a pride or ego factor that was implicated in several near misses. Experienced workers seem to be especially prone to getting in trouble when dealing with lingering hazards that were discovered after completion of the initial hazard-reduction work or after the area was already opened to the public. The desire to open terrain as planned or to keep terrain open affected their judgment, causing experienced workers to take chances they would not normally take instead of closing the area in question.

Risk homeostasis, the theory that people tend to maintain their own fixed level of acceptable risk, may also factor into experienced patrollers’ decisions that lead to near misses.

Other common distractions that materialized during hazard-reduction work included explosives misfires, equipment failure, partner dynamics, weather, physical fatigue, and the promise of powder skiing. In four instances, patrollers were preoccupied with retrieving a dud explosive and failed to recognize the avalanche hazard that existed before the explosive was deployed, resulting in their being caught while retrieving the misfire.

RELATIONSHIP ISSUES: HONEY, WE NEED TO TALK

Poor communication contributed to 40% of the observed near misses. We noted communication failures both in the pre-route stage and just before or during the incident. In a few cases, the partners’ expectations of each other were unclear during the route. In those cases, the less experienced partner seemed to be expecting the more experienced partner to watch over them, and the more experienced patroller expected their partner to make better decisions (i.e., choosing a more secure safe zone or ski-cutting path). In some cases, route leaders left inexperienced patrollers to make decisions beyond their ability level. In two cases, the control team failed to understand what was expected of them and inadvertently left some “cleanup” work that a patroller discovered after hazard-reduction work was completed. In both of these instances, the patroller was skiing by himself and was either caught in a slide or barely managed to avoid being caught in an unexpected avalanche. In 10 cases, one of the patrollers on the route realized that his partner was on “a slippery slope” but still failed to warn his partner before the ensuing close call. Rookie patrollers are often apprehensive to acknowledge they are not clear on their assigned tasks, and this communication dynamic can cause problems for everyone involved.

I WILL LOOK AT ANY ADDITIONAL EVIDENCE TO CONFIRM THE OPINION TO WHICH I HAVE ALREADY COME

—Lord Molson, British Politician 1903-1991

Moe Sizlack and Barney Gumble were on an avalanche-control route that entailed traversing above a set of steep chutes and blasting their start zones. They triggered avalanches in the first three chutes and decided to ski across the fourth chute’s



An example of miscommunication between the van driver and the control crew above the road. The driver was trying to block the road from traffic, but wasn't clear on where to park the van. *Photo by John Hooker*

start zone. Sure enough, they felt the start zone collapse and heard the tell-tale *whumph* as Moe skied across. At this point, Moe said “[I] don’t think it is going to propagate anywhere,” and he started to ski down the chute, leaving Barney scratching his head. He waited for Moe make it to a safe zone, threw a shot for good measure and triggered an avalanche. Why did Moe disregard so many signs of instability and ski the fourth chute? Unfortunately, our mind often surrenders to the temptations of motivated reasoning, drawing conclusions that we want to draw instead of objectively examining the situation at hand. An impressive 42% of our cases involved patrollers missing clear signs of instability due to motivated reasoning. In the avalanche world, professionals can be blinded by attitude, preconceived notions about the snowpack, and skiing plans or goals. One strong promoter to such motivated reasoning is known as “powder fever.” Ski patrollers can develop a sense of entitlement toward those elusive first tracks, and they often view them as compensation for comparatively low wages. The allure of a great powder run contributed to several patroller near misses.

**FOOL ME ONCE, TRICK ON ME;
FOOL ME FOUR TIMES, I KNOW I’LL BE RIGHT NEXT TIME**

Homer Simpson is a well-respected, well-liked, level-headed, hard-working ski patroller. Homer has more than 20 years of patrolling experience and is considered the “go-to guy” in many aspects of the job. In the past two years, Homer was caught in four different avalanches in adjacent slide paths while trying to ski cut hard slabs. Every time one of the forecasters tried to speak with Homer about these incidents, he replied, “This is not a big deal.” Clearly Homer’s situation is not an isolated occurrence, and other patrollers most likely have similar tales of woe. This begs the obvious question: why does a talented patroller like Homer continue to fall into the same avalanche trap again and again? Social psychologists Tavris and Aronson (2007) would argue that Homer’s effort to reduce cognitive dissonance is responsible for his puzzling actions.

Cognitive dissonance describes the internal conflict that ensues when someone holds two inconsistent or polarizing cognitions (ideas, attitudes, beliefs, or opinions). As an example, consider an overweight individual who is dieting and exercising in an attempt to lose weight; this individual also wants to skip their daily exercise session and go to all-you-can-eat night at the local pizzeria, creating cognitive dissonance. We tend to view ourselves in a positive light as intelligent, rational human beings. When we do something that goes against our beliefs, we need to justify our actions to maintain our positive view of ourselves. In our example, the dieter who devoured the entire pizza might rationalize it by deciding, “The pizza had veggies on it instead of meat, so it was actually a healthy choice. And I exercised so hard yesterday, I deserved a bonus. I’ll get back to the gym tomorrow.”

In some cases individuals repeat the same action that initially created the cognitive dissonance as part of an effort to justify their behavior. In Homer’s case, we hypothesize that Homer realizes that getting caught in an avalanche is not the desired outcome of avalanche hazard-reduction work. He understands that applying explosives to the slope with hard-slab conditions is a better option. In an effort to rationalize his decision to ski cut hard slabs after being repeatedly caught,

Homer treats those incidents as “non-events.” To further justify his decisions to ski cut rather than shoot the slope, he continues ski cutting the same slopes in similar conditions, feeling that each time he “gets it right” will help rationalize the close calls from the past. The bad news is that we are all susceptible to repeating our mistakes, as we all have the same strong drive to self-justify our questionable decisions. The good news is that we can reduce cognitive dissonance’s implications simply by being aware of the issue.

Identifying major decision-making themes and sorting the decision-making factors in our data set left substantial room for interpretation. We chose to create typologies (the “characters”) to sort and present the pertinent decision-making factors. While others would undoubtedly use different criteria to analyze our data, we feel they would reach the same general conclusions: complex snowpack issues played a significant role in a minority of the cases, and decision-making factors played a significant role in the vast majority of the cases. Further, most incidents were a result of multiple decision-making factors. If our data is indicative of ski-area near misses as a whole, increased human-factor training can reduce the number of incidents going forward.

Some degree of human error is inevitable in avalanche work or any other complex environment or situation. The commercial aviation industry realized this three decades ago and developed Crew Resource Management (CRM), a training system to reduce and manage human error. CRM training topics typically cover group dynamics, communication, decision-making strategies, “breaking the chain of errors,” and recognition of human factors. The FAA currently requires aviation cockpit personnel to train annually with CRM.

Seeing the commercial aviation industry’s success, other industries and operations implemented CRM training. The US Air Force determined that 18% of in-flight mishaps occurring from 1992-2002 resulted from aircraft-maintenance human errors. The military was already training pilots with CRM, and maintenance personnel then began a modified CRM program (US Air Force Safety Center). At the Nebraska Medical Center, the rate of uneventful cardiac cauterizations and surgeries rose from 21% to 62% after only two years of CRM training for surgical teams.

How is CRM training typically received by trainees? Some pilots were initially hesitant to accept the training, calling it “charm school” or “psycho babble.” The airline industry refers to these individuals as, among other terms, “cowboys.” Western US ski patrollers do not have to stretch their imaginations too far to picture a few grizzled veteran coworkers having a similar reaction to a program like this. However, the vast majority of airline personnel described CRM as important, effective training, and it has become the safety engineering world’s standard for human-factor training programs. Implementing CRM training programs at US ski areas would not happen overnight, but data from our study and evidence from other industries indicate that avalanche programs would likely be well served to spend more of their training resources, or additional resources, on human-factor safety training.

“Safety culture” is a term often thrown around to describe the way workplace safety and safety training are managed. So how do we accurately define safety culture? Noted industrial-safety expert Dr Dan Petersen defines it loosely as “the

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AVALANCHE NEAR MISSES
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This crown line provides evidence of a skier-triggered near miss involving multiple paths on the south face of Lone Mountain at Big Sky, Montana. Photo by Scotty Savage

way it is around here” and notes that workers must believe that safety is “a key value of their organization.” According to Petersen, an organization’s leadership plays a crucial role in shaping safety culture.

We believe that ski area avalanche-safety culture in the western US can be improved. The classic ski patroller mind-set seems to be that experience is gained by surviving a string of near misses and that taking rides is somewhat of a rite of passage. The physicist Niels Bohr might have shared this mind-set, defining an expert as “a person who has made all the mistakes that can be made in a very narrow field.” People do tend to learn better from failure than from success, but we do not recommend building expertise by attempting to make every possible mistake in the avalanche field. While patrollers obviously learn a lot from first-hand experience, discussing near misses can be an extremely valuable educational tool. Open communication within the operation and internal debriefs are excellent starting points. Mistakes are the building blocks of good decision-making. Therefore, near-miss incidents should be viewed as positive learning experiences by the organization as a whole. Ideally, incident debriefs occur after the participants have had some time to reflect on the near miss, but within a few days of the incident. One way to promote open discussion of near misses is to enlist experienced and respected workers to discuss incidents from their past with the entire organization. Healthy discussions where no one fears repercussions should help workers like Moe, Barney, and Homer from the earlier examples recognize and deal with the decision-making traps that lured them into near misses. Further, experience shows that workers openly discussing near misses are more likely to communicate well and adopt a “see it, say it, fix it” approach in the field. Role-play training exercises are a logical next step and are used successfully by avalanche programs and several other industries.

Participating in supervised decision-making and “what if” exercises covering a wide range of situations in the field and discussing actual near miss incidents builds patrollers’ experience bases more effectively than solely reading about near-miss incidents. Still, documenting near misses is extremely important. Studying those reports potentially improves individuals’ decision-making and alerts organizations to unsafe trends, practices, and specific training needs. The entire avalanche industry would benefit greatly from a large near-miss data set that could be evaluated by experienced professionals. Unfortunately, professional near misses are under reported and poorly documented. Incidents often go unreported to avalanche supervisors because workers fear being ridiculed by their peers or taken off routes. One of the ski areas providing data for this study attempts to make documentation more entertaining by requiring that patrollers involved in near misses write a description of the incident from the point of reference of their choice. Another patrol uses a computerized near-miss reporting system, covering all aspects of ski patrolling. However, there is no organized database of professional near-miss incidents in the United States, and ski patrols sometimes hesitate to share near-miss incidents outside the organization. The firefighting industry created a Web-based system to document and review near misses at www.firefighternearmiss.com; clearly, the avalanche-hazard-reduction industry would benefit from a similar system.

Firefighters, airlines, military operations, health-care professionals, and others have studied near misses in their specific fields and concluded that human factors play a significant role. These industries developed successful training programs and databases to reduce human error and ultimately save lives and money. The limited number of avalanche near miss cases that we analyzed show that avalanche professionals are no different from pilots, firefighters, and surgical teams in that human factors in decision-making lead to many of our close calls, and we would benefit from increased human-factor training and research. Simply acknowledging the important role that human factors play in near misses may reduce their rate of incidence, but awareness alone will not solve the problem. Debriefing incidents, openly discussing near misses, and participating in decision-making exercises

in controlled environments could aid in preventing near misses, and ski patrols should consider devoting more pre-season training resources to human-factors topics. The avalanche industry has a solid track record of adapting other industries’ technologies to solve our own complex problems – implementing avalanche-specific, CRM-style training programs would help continue to ensure that the most dangerous part of a ski patroller’s day is driving to work.

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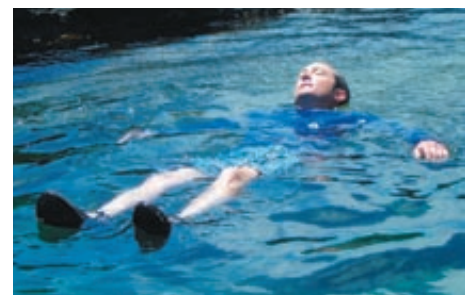
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Scotty Savage (skipatrol@bigskyresort.com) is the snow safety director at Big Sky Resort in Montana and the AAA section representative for the Intermountain North region. He is spending way too much time in Vail, CO, operating rooms lately in a quest to resume working and dancing to ska music with his 4-year old.

Ron Simenhois is a ski patroller in Colorado and New Zealand. After the birth of his first child, he decided to utilize his pre-ski patrolling experience to make his life safer. He has developed tools to improve safety culture, decision-making and communication flow. Ron would be happy to talk to anyone interested in decision-making related training, safety culture, or their near misses. ❄️





Bear Valley Snow Safety Director Mattly Trent tosses a bomb on a 30" day. Photo by Mike Bartholow

Sierra Avalanche Center

The winter of 2008/09 got off to a late start in the Sierra Nevada. After a warm and dry fall, several storm systems passed through the area during the last week of December, covering the forecast area with several feet of snow, but then high pressure returned and lasted for most of the month of January. After several weeks, a corn cycle occurred, turning thoughts to, "This will be the shortest winter on record." In late January the weather pattern changed with February and the first week of March bringing winter back in full force. Just over 200" of snow fell during these five weeks. During late February, a layer of faceted snow crystals above the late January rain crust became a weak layer that led to persistent deep-slab instability. Through March and April, small snow storms punctuated by periods of high pressure kept the snowpack from melting too quickly. By the end of April the Sierra snowpack in our forecast area was at about 85% of average. Of the three avalanche fatalities that occurred in the region this past winter, one of them was directly related to the persistent weak layer that formed in late February. More details on the three avalanche fatalities this past season can be found at www.avalanche.org.

The Sierra Avalanche Center set two records this year. First, we reached a new high for the number of advisory users during winter 2008/09. The number of seasonal hits on the Sierra Avalanche Center Web site jumped from 143,231 to 236,700 this year. Combined with the number of phone calls to the avalanche advisory hotline, the advisory was accessed over 250,000 times this winter. We received several positive comments from our users on improvements made to the advisory this year. One improvement came directly from the increase in public users, as they submitted more observations to us than ever before. These observations combined with more consistent and professional observations from the local ski patrols and from our professional observer Steve Reynaud allowed us to write more accurate forecasts with specific examples, photos, and data to support the predictions. We implemented the danger rose to display avalanche danger on the forecast page. Our users liked this change as well.



Brandon Schwartz on Carpenter Peak. Photo by Andy Anderson

The Sierra Avalanche Center's second record this winter belongs to the Board of Directors, who raised more money for the avalanche center than ever before. Through their hard work and dedication the Board again convinced Heavenly, Kirkwood, Northstar at Tahoe, Sugar Bowl, Mt Rose, and Alpine Meadows to donate a total of 2050 lift tickets to SAC this winter. Working with SnowBomb.com to sell these tickets online, over \$56,000 was raised. The Board also collected enough gear from companies such as BCA, Garmont, Mountain Hardware, and Voilé to hold a monthly raffle for people who donated \$100 or more to the center. The raffles they raised about \$7000 from 70 people.

As SAC has become more well known and respected in the community, the Board has formed and maintained relationships with several local organizations and businesses that use the avalanche advisory and support it financially. This includes Heavenly Ski

Patrol, Porters Lake Tahoe, Tahoe Adventure Film Festival, Thin Air Motor Sports, Tahoe Nordic Ski Patrol, Tahoe Nordic Search and Rescue, and the Eldorado Nordic Search and Rescue. By the end of the season, \$73,500 was raised to help fund operational costs and forecaster salaries. The Tahoe National Forest and Forest Service Region 5 continued to donate infrastructure support (truck, gas, office, etc.) and contributed \$5000 towards forecaster salaries during 2008/09.

The partnership between the Sierra Avalanche Center Board of Directors and the Tahoe National Forest remains strong. Both parties have shown great commitment and support for continuing this avalanche center. With help from both sides, as well as the community at large, we hope to add a third forecaster and make at least two of the forecasting positions permanent in the future. As an avalanche center, we will continue to provide a quality avalanche forecast for the central Sierra Nevada between Yuba Pass and Ebbetts Pass for many years to come.

—Andy Anderson, forecaster

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West Central Montana Avalanche Center

An early December rain to 10,000', a shallow snowpack with 10 days of negative 20-degree temperatures followed by a series of warm Pacific storms set the stage for one of the most active avalanche cycles seen in this area in decades. Avalanches were a lead story in all the local news media during the holidays as we issued four separate avalanche warnings during this period. People were very aware of the dangerous conditions and made good decisions about where they traveled. We are very happy to report no avalanche accidents within our advisory area this year.

Our program continued to grow with direct monetary support from the nonprofit West Central Montana Avalanche Foundation (WCMAF) and a Recreation Trails Program grant received from Montana Fish Wildlife and Parks. The grant directly paid for the addition of a field day for two people and the posting of another avalanche advisory. We posted 33 advisories this season – more than double the number posted last year.

The WCMAF purchased a Beacon Basin training park, which we installed at the Lolo Pass Visitor Center in early January. We plan to install similar parks next year at Lost Trail and Montana Snowbowl ski areas.

We continue to provide education opportunities in the Missoula and surrounding communities within the school systems, snowmobile clubs, SAR organizations, and backcountry snowmobilers and skiers. We reached approximately 1,200 people through these sessions.

WCMAF coordinated several very successful benefit events in October and November. The biggest and now signature event is the annual Burning Dog/ Pray for Snow party sponsored by Big Sky Brewing. Nearly 1000 people attended this outdoor music, film, food, and outdoor-gear retailer fest in mid-October.

The University of Montana continues to contribute Dudley Improta's time for field assessments, writing advisories, and teaching avalanche-safety classes in the community. Dudley's experience as an educator, guide, and avalanche-safety expert is invaluable to our forecasting and education program, and UM deserves special recognition for this. The quality of the program would not be as good as it is without this contribution.

The Bitterroot, Clearwater, and Lolo National Forests contributed field time for 10 employees to collect snow stability data on their respective forests.

The Missoula office of the National Weather Service again provided daily backcountry weather forecasts specific to our advisory area as well as Glacier Country's Avalanche Advisory program. During periods of high avalanche danger when it was critical to broadcast a warning to the public, we easily submitted this warning to their Web site with a map graphic and short text pointing readers to our Web site for more detailed information. A popular local radio station broadcast the avalanche danger on the Monday, Friday, and Saturday morning shows, reaching an estimated 5000 listeners each day. Web site usage numbers are up from 36,938 visits recorded last year to 44,979 unique visits to missoulaavalanche.org.

Gerry Connell and Steve Thompson volunteered their time and snowmobiles to report on snowpack conditions in the heavily used areas in the southern Swan and Mission Mountains near Seeley Lake, MT. Their dedication allows us to include this area in our advisory program. They also instruct avalanche-safety classes for the local school, snowmobile club, and search and rescue organization in Seeley Lake. Local backcountry skiers also contributed a significant number of voluntary observations this winter that helps us fill in the gaps in the massive area we try to cover.

The season concluded with the mountains very close to 100% normal snowpack for the year.

—Steve Karkanen, director



Sue Burak of the ESAC shows off well-developed depth hoar in March of 2009.

Photo by Andy Selters

Eastern Sierra Avalanche Center - Inyo National Forest

The winter of 2008/09 will be remembered for depth hoar, weather extremes, and sketchy snow conditions. For the first time in anyone's memory, the eastern Sierra had real Rocky Mountain depth hoar which affected snow stability the entire season. Unstable snow conditions lasted for up to a week after snowfall, instead of a day or two in the more typical and boring maritime snow climate we usually see here. Natural and skier-triggered avalanches occurred in clear, dry weather up to a week after storms moved east of the area. Two wet-slab avalanche



A snowboarder landing from the kicker above triggered this 2' crown, which stepped down to the uncharacteristic Sierra depth hoar.

Photo by Gabe Taylor



Skier-triggered avalanche, Convict Lake, February 21, 2009.

Photo by Sue Burak

cycles occurred in February and April, which is another unusual occurrence here.

The early season continental snowpack was followed by a parade of Pacific storms, loading the unusually weak snowpack. Instead of snow stability improving within a day or two after a storm, the snowpack was far more tricky, unpredictable, and unforgiving. Two wet storms resulted in an ice lens below about 10,000' and a density and grain-size change above 10,000'. Large facets formed above and below this layer, and many avalanches occurred on this layer.

Surface hoar, usually hard to detect in stability tests in the eastern Sierra, was found in snowpits at the end of January and early February. Depth hoar and large facets falling like sand out of snowpit walls,

widespread whumphing and cracking, and many huge full-depth avalanches presented new and exciting forecasting challenges this season.

Another challenge was trying to convince the recreating public that the snowpack was very different this year. Letting one's guard down and proceeding with sloppy habits learned from a more forgiving snowpack simply would not work this year. Despite many more skier-triggered slides this season, no one was seriously hurt, and there were no fatalities.

This season, weak to moderate La Niña conditions influenced the trajectory and strength of storms. Fortunately, the Madden Julian Oscillation had several active phases that brought four multi-day storms to the Sierra. The MJO is an intra-annual fluctuation in the Indian and western Pacific Ocean that strongly affects the winter jet stream and can bring moist storms to the West Coast and the Sierra.

Orographic lift was often the only mechanism bringing snowfall, because the jet stream was too far north for favorable storm dynamics. Most snowfall occurred as a result of air masses cooling as they moved from the low elevations of the Central Valley up to the low point of the Sierra Crest at Mammoth Pass and Mammoth Mountain. The process favors snowfall on Mammoth Mountain due to the lack of obstruction to air flow and channeling effects of the topography.

The season started in mid-December with an active phase of the MJO bringing two storms to the Sierra Nevada. Mammoth Mountain received 120" in December which surpasses the long-term average by 50". Mountain areas south of Mammoth received much less snow because the Sierra Crest is several thousand feet higher and blocks lifting air masses effectively.

Snowpack depths at the end of the December were shallow for the time of year, ranging from about 3-4' around the Mammoth frontcountry and 1-2' south and north of Mammoth. Hitting rocks or downed trees was more likely than triggering an avalanche. Lousy snow cover kept repair shops in business, and the local physical therapy department was busy with bruised and broken skiers and riders.

La Niña conditions continued during January 2009, as negative sea-surface temperature anomalies strengthened across the central and east central equatorial Pacific. A dome of high pressure formed and strengthened over the western US. No snow fell in the eastern Sierra for three weeks! Warm days, cold clear nights, and a shallow snowpack resulted in temperature gradients of 13-150°C per meter, favoring kinetic growth. The entire snowpack became a faceted nightmare. Snowpit tests often failed as depth hoar collapsed while isolating columns.

By the middle of January, the Madden Julian Oscillation signal had a flareup, though flareups are not a strong MJO event. Ten days after the flareup, heavy snowfall and a short period of rain and wet snow occurred from January 22-25. The rain and wet new snow formed a thick melt-freeze crust that became the second significant layer in the snowpack. Large facets formed above and below this lens, and the lens became the sliding layer for some very deep, dry, and wet-slab avalanches in February, March, and April.

February was a wild month as storm after storm loaded the fragile, low-density depth hoar and the faceted snow above the January melt freeze layer. There were



Probe teams and avalanche dogs on Crown Butte near Cooke City, MT, search for a snowmobiler who forgot to turn on his beacon. He was caught when he got stuck near the top of this slope where the crown was 15' tall. *Photo by N Bilton*

more natural and skier-triggered avalanches in February than long-time patrollers, local skiers, and the forecaster had ever seen. Wind loading and high rates of precipitation led to very unstable and unpredictable avalanche conditions both at the developed ski areas and the backcountry. A wet-slab avalanche cycle occurred in one small sub basin south of Mammoth.

On February 19, three days after a February storm dropped over 5' of snow in the Sonora Pass area north of Mammoth, a snowboarder landing a jump triggered a big avalanche. The avalanche stepped down to the depth hoar on the ground. The rider had enough speed to escape the slide he triggered.

A few days later, a skier triggered an avalanche in a 2' snowpack. (*see photo on page 20*)

March started with a bang with an active MJO and 4' of snow and 6" of water falling at Mammoth and June Mountains in the first four days of the month. A widespread slab-avalanche cycle occurred after this storm, but the slabs were shallow and occurred mainly in density changes in the storm snow. The Mammoth area received about 60" of snowfall for the month, while areas south picked up 20". The shallow snowpacks in the southern Sierra still had well-developed depth hoar in mid-March, but the layer was not as reactive in extended column tests as in February until it got wet.

Wet-snow avalanches returned in mid-March as solar radiation triggered wet avalanches in shallow rocky areas in the southern Sierra. After a couple of weeks, wet slides became more widespread in the deeper snowpacks around Mammoth. The maritime gods and goddesses returned to the east side by the last week in March. 12-16" of snow and over 2" of water was added to the pack in a 12-hour period. Expecting to see a widespread natural avalanche cycle, I was surprised and disappointed to see only a couple of isolated dry slab avalanches. Some of the best powder skiing of the season occurred the week after the storm.

A wet-slab avalanche cycle occurred near the end of April, followed by the strongest MJO event of the season. A two-day storm brought about a foot of new snow to Mammoth with 1-2' of snow falling along the Sierra Crest in the southern Sierra. The Tioga Pass area north of Mammoth also picked up 1-2' of high-density snow. Skiers and riders hit every steep chute and gully close to the Tioga Pass Road in a feeding frenzy of climbing and skiing above other parties on the slopes, knocking wet slides onto parties below, skiing naked, and leaving unfinished cornice cuts perched above popular ski descents. Hundreds of people skied and snowboarded on top of each other that weekend, and amazingly no one was hurt or killed.

The final advisory of the season was issued on May 8, and the Forest Service avalanche center closed at the end of the May.

—Sue Burak, forecaster

Gallatin National Forest Avalanche Center

This fall southwest Montana received the snow bailout package denied to other areas, and we were hopeful it would provide a solid base. Everything looked good with warm wet weather and nearly 3' of strong, supportable snow on the ground as daily advisories began December 12. Temperatures then dropped to -20° F forming an ice crust surrounded by facets. Increasing snowfall placed a heavy load on this weak layer, prompting us to issue a warning on December 26 that lasted seven out of the next nine days. People triggered many avalanches during this time, and luckily no one was seriously injured or killed. One notable avalanche involved a snowmobiler buried over 6' deep and recovered alive by his partners. In mid-January snowfall finally stopped, and the sun came out for the first time in over a month.

Three people died in separate avalanches on Saturday, January 17. An experienced rider from Bozeman died near Cooke City on a slope covered with snowmobile tracks when he got stuck near the apex of his climb. While attempting to free his sled, it started tumbling downhill and hit an exposed rock causing the slope to fracture 15' deep. His wife and his partners began an immediate search but could not find him because he had forgotten to turn on his beacon. He was found the following day. Another experienced rider from Bozeman died just outside the advisory area when he momentarily rode away from a group of 13. Once his partners noticed he was missing, they followed his tracks leading into avalanche debris on a small slope. They conducted an immediate beacon search and quickly dug him out, but it was too late. The third victim died near West Yellowstone. His partners could not find him as they attempted an unorganized search. A student from two GNFAAC snowmobile avalanche classes witnessed the avalanche and arrived eight minutes later. He took command of the scene, instructed everyone to turn off their beacons, located the victim's signal, and organized shoveling efforts. Unfortunately the rider was buried for 20 minutes under 6' of debris.

Human-triggered avalanches occurred sporadically during a period of cold dry weather lasting through mid-February. During this time the mountains were occasionally dusted with an inch or two of low-density snow in which several faceted layers formed. They were buried when significant snowfall returned on February 15. By early March numerous people experienced close calls as avalanche activity predictably increased with each storm. Near the end of March rain and very warm temperatures triggered another increase in avalanche activity. A lone skier was caught doing a ski cut and carried into dense timber where he broke his

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This small slope killed a snowmobiler when he momentarily rode away from his group. The victim's head was buried under 1-2' of debris. We don't know what the victim was thinking, but the rest of the group, all carrying rescue gear, was well aware of current avalanche conditions. *Photo by Karl Birkeland*

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femur. Hearing his cries for help, another lone skier placed a call for Search and Rescue on his cell phone. The ceiling was just high enough for Gallatin County SAR to use a helicopter and short haul the victim to a waiting ambulance.

Following this accident, 3" of water fell with very cold temperatures. On many slopes the wet snowpack refroze and was able to support this load. Other slopes had a deep and overall strong snowpack, yet we continued to find a few slopes with facets from the mid-winter dry period that were still reactive in stability tests.

On April 10 we closed our doors after issuing 122 advisories to 3,239 people per day on average, a 20% increase over last season. We continued posting videos on YouTube where they were viewed over 23,000 times. With strong support from the Friends and Jay Pape working as education coordinator, we provided classes to 4,300 people – almost 10% more than last year. Instructors Dale Gullet, Angela Patnode, and Jay Pape continued to teach many of these classes, logging tons of miles traveling across Montana. They traveled to Helena, Butte, Big Timber, Livingston, Great Falls, Anaconda, West Yellowstone, Cooke City, and even Cody, WY, reaching many diverse groups hungry for avalanche education.

Sidecountry use in our advisory area grew this year with a new lift and open boundaries at Bridger Bowl. Skiers lost the popular Slushmans area but gained unbelievably easy access to a major peak. Doug worked with Bridger Bowl to provide a short movie produced by Sam Lowe-Anker that highlighted differences between the backcountry and the ski area. 5000 copies were made and given to each season-pass holder. Backcountry use also grew in Hyalite Canyon by both skiers and climbers as the access road was plowed all winter.



Mark Staples is bummed that his boss made him bring skis on this field day and had to wear ski boots instead of Sorels. He and his partner pinned the throttle and rode to every pit location without touching their skis. They agreed that parking the sleds in the flats and skinning to a snowpit is like walking around a climb to drop a top rope instead of leading it. *Photo courtesy GNFAC*

Yamaha sponsored us again providing 1000cc Nytros which we put 1200 miles on. These sleds continue to be an incredible resource, allowing us to teach effective snowmobile classes and access popular riding areas. We find ourselves frequently leaving skis at home yet digging more snowpits across incredibly wide areas. Due to legal issues in Montana this year, we partnered with Island Park Adventures in Idaho and look forward to working with that shop and Yamaha again next year.

Lastly we continue to receive many invaluable observations from backcountry users. Ski patrollers at Big Sky, Bridger, Moonlight, and the Yellowstone Club take time at the end of every day to send us reports. Thanks to everyone who contributed to a successful season at the GNFAC. *—Mark Staples, forecaster*

Payette Avalanche Center

The west central mountains of Idaho were not spared from the feast or famine snowpack of the 2009 season. Starting in mid-December, with a 3' light-density

snowfall on bare ground, into the multi-week high pressure of January and February, and on through the extended faceting of late winter and early spring, local backcountry users were kept on their toes with high consequences for poor decisions.

Our mountains generally receive a deep snowpack with enough moisture from the northwest and warming from the south to keep long-term instabilities in check, but this year was different. We followed suit with the rest of the region and continually warned the public about deep instabilities, especially on north-facing slopes. Two serious accidents occurred within our forecast area this past season, both related to deeply buried surface facets which formed in a long period of high pressure from mid-January to the beginning of February. Both accident reports can be found on Avalanche.org. One case involved a snowmobiler who was seriously injured, and the other involved a group of skiers where four members of the party went for a ride. All survived.

The Payette Avalanche Center issued 46 advisories during the 2008/09 season, generally three days a week starting December 12 and ending April 1. While the average hazard lay around Moderate, north-facing slopes harbored Considerable hazard for much of the later season and tended to catch people off guard. Numerous large natural and human-triggered slides were reported on these slopes the likes of which have not been seen in recent years.

We taught or partnered with other organizations such as our Friends group and Idaho Department of Parks and Recreation to teach eight avalanche courses reaching approximately 440 students. These classes ranged from small beacon clinics to large public school assemblies. Looking into next season we've hired a new forecaster, and we're partnering with the Boise National Forest to extend our advisory coverage to the south and increase the number of advisories posted per week. Funding for our program has increased, and we continue to build and maintain great partnerships with other agencies such as Idaho Department of Parks and Recreation. We'd like to thank our Friends organization, the local community, the city of McCall, Idaho Department of Parks and Recreation, and the local resource advisory committee for continuing to support avalanche awareness. *—John Groom*



April evidence of January full-depth avalanching. Mt Stanton, Glacier NP. *Photo by Stan Bones*

Northwestern Montana – Glacier Country Avalanche Center

Overall the winter of 2008/09 was a good one for northwestern Montana. The season began warm and dry, but finished near or exceeding average SWE amounts. Early season was unseasonably warm with precipitation falling mostly in the form of rain. In mid-December a blast of arctic air combined with near-normal snowfall to produce a deepening and fragile snowpack over most of the region. Increasing storm activity after Christmas created a snow cover with inverted strength. In several locations, this "house of cards" toppled in early January when a Pacific front invaded with considerable moisture and rapidly warming temperatures. This event was our most significant avalanche cycle of the season with numerous paths releasing at or near full depth.

In February normal snowfall set in for the remainder of the winter. In mid-April, instead of initiating melt season, cool temperatures and continuing precipitation sustained the snowpack accumulation. At the time of this writing our mid- and upper-level snow covers continue to grow.

Several arctic blasts and temperature-inversion episodes produced cool conditions, particularly in the valleys. Retention of low-elevation snow exceeded normal, while high-elevation accumulations somewhat lagged.

NW Montana only had two documented avalanche incidents: the first a snowmobiler in late December and the second a skier in late April. Both were only partially buried and uninjured. A buried surface hoar layer in early March is rumored to have produced more incidents, but solid information was never forthcoming.

The avalanche center's education program was a success again this year with returning seasonal employee, Leah Taylor, who spearheaded numerous transceiver and avalanche awareness sessions and developed programs for elementary and secondary school students.

Forest recreational users attended two separate and free intense avalanche-awareness classes offered by the Flathead National Forest. The first session was tailored to skiers, snowboarders, and mountaineers and offered in early January. The second session was tailored to snowmobilers and was well attended by 20+ interested riders in late January and early February.

Twice weekly avalanche advisories were posted on the GCAC Web page and offered via email and phone voice message. The Web page also offered a forum for backcountry observation reports. The Forest Service received another grant from the Montana Department of Fish, Wildlife & Parks trails program for avalanche education. *—Tony Willits & Stan Bones, avalanche & snow specialists*

Colorado Avalanche Information Center

Winter had not even begun when our first avalanche incident was reported. On September 16, a skier took a ride in a shallow soft slab over summer firn in the Front Range Zone. Fortunately they escaped with only minor injuries. For the past several seasons, most people have kept to hiking and mountain biking in the fall, waiting until at least October or November to start their avalanche season.

Fall of 2008 in Colorado had a similar feel as 2007. October snows turned to depth hoar during a dry November. Grand Mesa, a usually snowy location, saw only 28.5" of snow in November, which was 52% of normal. The Red Mountain Pass study plot recorded 32", and further south, Molas Pass had only 11". Telluride's snowfall was 38% of normal. Only one incident to report from November: three roped climbers were caught and carried about 1,200 vertical feet in another Front Range Zone avalanche. Even with so little snow, 40 reported avalanches filtered through the center. All that was about to change as December would be a completely different beast.

Winter returned right on schedule for the annual Birds of Prey World Cup races at Beaver Creek the first week of December. There is truth to the saying, "If you want it to snow, host a World Cup Downhill." Snow it did; several areas reported record or near-record snowfalls. Telluride added up 113.5" of snow, beating the old record, set just last year, of 95". It was a whopping 301% of normal snowfall. The Breckenridge ski area saw 102" at their upper station: 141% of average.

December was by far the most dangerous month across Colorado. The month produced all four fatalities for the 2008/09 Colorado avalanche season. Snows continued almost nonstop from the start of World Cup week through the beginning of 2009. December was also the most active avalanche month with 615 avalanches called or emailed into the center. There were 21 avalanche incidents that caught 27 people. On December 14, a one-time Aspen and Breckenridge professional ski patroller skiing solo triggered and died in a small slide just outside the Aspen ski area. On March 17, a lone snowboarder died in an avalanche near the town of Crested Butte. The last fatalities of the season were two snowmobilers caught and buried near Gravel Mountain outside Granby just after Christmas.

January was as quiet as December was busy. There were only 6 avalanche incidents from the 330 reported slides and 10 people caught. One of these near misses caught three snowboarders in East Vail. Their partner, on skis, avoided the slide and was able to dig all three out of the debris. In another miraculous incident, three backcountry riders near Vail triggered a large avalanche while ascending an open slope. All three ended up buried but somehow managed to dig themselves out after a couple hours.

February and March both saw long dry spells followed by big dumps and Arizona dust. February added another 393 avalanches to the state's 2008/09 tally and saw seven incidents and nine people caught. On February 15, a college student from Wyoming had a near brush with mortality on Grays Peak (14,270' asl) in

the Front Range. On his third turn he triggered a small slab, which eventually encompassed much of the precipitous East Face. He lost some equipment – and probably a pair of shorts.

Spring sprang in March where the first couple of weeks brought us right to the cusp of a wet slide cycle. Temperatures continued to rise, peaking on March 22 with temperatures in the mid- to upper 50s. Winter returned on March 23 with snow, cold temperatures, and a state-wide dust event (the seventh of the season). Snowfall totals for the end of March, early April storm cycle added into the feet. There were 209 avalanches with only two incidents with three people caught. Another 15 avalanches in early April brought the season total of reported avalanches to 1603. This is well below the average of 2293. Many of the April avalanches ran on the eighth dust storm layer of the season. As we finish this up, another storm is looming on the horizon; winter is not ready to loosen its grip just yet.

Education

The CAIC hosted three professional development workshops and taught 110 avalanche classes for the public during the 2008/09 season. The eighth annual Colorado Snow and Avalanche Workshop (CSAW) was held on October 8 and had over 250 attendees. This season the venue moved to the National Mining Hall of Fame in Leadville. It was the best-attended workshop yet. The CAIC also teamed up with the American Institute for Avalanche Research and Education (AIARE) and the Colorado Mountain College to sponsor two professional development workshops for avalanche professionals. The first was held in early February and with the focus, "Mountain Weather and Forecasting." Presenters included John Snook (CAIC), Mike Meyers (NWS - Grand Junction), and Doug Wesley (COMET/NCAR). The workshop was well received and we plan on hosting a three-day version in mid-October of 2009. The second was in April with the topic, "Wet Snow and Avalanches." Presenters included Ethan Greene (CAIC), Kelly Elder (USDA Forest Service), Simon Trautman (CAIC), Leif Borgeson (Arapahoe Basin), Erich Peitzsch (USGS), Brian Lazar (AIARE and Stratus Consulting), and Brad Sawtell (CAIC).

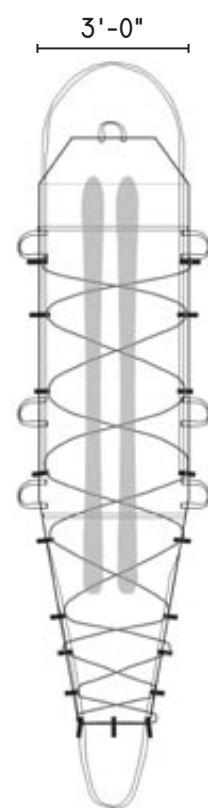
Staff Changes

The CAIC had two staff changes for the 2008/09 operating season. Ann Mellick moved from the main office in Boulder to the Telluride office, which covers the northern San Juan backcountry zone and CDOT operations on Lizard Head Pass. Sadly for Ann, she brought the renowned Front Range winds to the San Juan with her. Take heart Ann, it cannot be this windy two years in a row. Simon Trautman moved down from Moonlight Basin in Montana to fill Ann's former position in the Boulder office.

— Scott Toepfer

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SPECIFICATIONS

NO ASSEMBLY REQUIRED

BUILT FOR PERSON 5' TO 6.5' (135CM-200CM) TALL

DURABLE WATERPROOF MATERIAL THAT MOVES EASILY THROUGH SNOW

OCCUPANT AND SKIS FULLY SECURED INSIDE SLED FOR STABILITY AND SUPPORT

NYLON SNOW GUARD PROTECTS OCCUPANT FROM MOISTURE AND ROPE ABRASION

TOW STRAPS AT FEET AND HEAD

MULTIPLE HANDLES TO AID IN PATIENT TRANSFER

NYLON STUFF SACK

DESIGNED AND BUILT IN BC 🇨🇦

NAC ROUNDUP 2008/09

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Kachina Peaks Avalanche Center

In retrospect, the winter in Arizona consisted of only two major storm cycles with a few minor events scattered throughout the rest of the season. After a prolonged warm and dry autumn, the snow year started in earnest with a series of storms dipping southward, the first of which blanketed San Francisco Peaks with over 60" of high-density snow. The cycle started on December 14 and by year's end 120" of snowfall had been recorded at 10,800'. In contrast, January was dry with only a few dustings and one more potent storm that laid down 14" on January 29. A second significant cycle of storms arrived during the second week in February, resulting in the only backcountry winter/ avalanche hazard press release issued by the Coconino County Sheriff's Department on February 9. Snow stability was variable following this cycle with several natural avalanches reported in the Inner Basin of San Francisco Peaks. For the rest of the season, new snow was limited to dust on crust. Seasonal snowfall totals at Arizona Snowbowl ski area were 77% of the 30-year mean, with a total of 205" recorded at 10,800'. Temperatures were generally a few degrees warmer than normal, except during April which was slightly cooler than average. Wind maximums were notably stronger than average, with at least one gust recorded at 100mph on Christmas night.

Backcountry recreational activity was at near-record levels, despite our erratic season. Predictably, a majority of the activity corresponded with the storm cycles. Assumptions on use levels are based on the number of winter backcountry permits issued by the Coconino National Forest and on KPAC Web site (www.kachinapeaks.org) activity. Web-site use was up over 15% from the previous year with more than 17,000 visits during the season, and the number of registered member/user (people registered to post or respond to observations) increased by 30%.

KPAC offered two avalanche awareness clinics with over 100 people attending. Through collaboration between KPAC and Prescott College, two level 1 courses filled and ran: one during January and another in February. There were no avalanche fatalities or even human-triggered avalanches reported in Arizona.

KPAC continues to receive broad local support. A user survey posted on our Web site and available at the Agassiz Lodge revealed that out of 220 respondents, 87% stated they would benefit from avalanche advisories, and 74% claimed that they would consider financially supporting such an effort. As a result, preliminary steps are underway to develop a collaborative relationship between Coconino National Forest and Kachina Peak Avalanche Center, Inc., which, if successful, may enable limited avalanche advisories to become a future reality.

—David Lovejoy



Photograph of a clear rain crust that formed on November 29, 2008. This crust and a persistent weak layer of faceted snow that formed upon it became the failure plane and bed surface for a deep-slab avalanche cycle that began in late December and lasted through January. Photo by Bob Comey

Bridger-Teton National Forest Avalanche Center

The 2008/09 season began slow but ended with above average snowfall (570"). Almost half of this snow fell during storm cycles that occurred in the latter part of December, mid-January, and late March.

In November stout rain crusts formed on two occasions. During the ensuing nights faceted snow developed above and between these slick layers. These crusts and persistent weak layers became the failure planes and bed surfaces for a deep-slab avalanche cycle that began in late December and continued until the end of January. A lack of sustained strong winds and periodic lulls in precipitation intensity produced minimal avalanche activity during the March storm cycle.

There were five avalanche fatalities in Wyoming. One occurred in an open area of the Jackson Hole Mountain Resort on December 27, 2008, after avalanche-hazard reduction efforts had been conducted and the incident slope had been open to the public for several hours. On January 2, 2009, an ice climber died in the South Fork Valley near Cody, Wyoming. Three snowmobilers died in the Snake River Range on February 27, 2009.

On New Year's Day a snowmobiler near Togwotee Pass was recovered, alive and well, by companions from a depth of 7'. On January 28, 2009, a skier was recovered alive and well by companions after being buried to a depth of 5' in a slide that occurred on Starvation Peak. There were nine other events in the backcountry that involved humans who were caught by avalanches but not seriously injured.

The Bridger-Teton National Forest Avalanche Center posted weekly snowpack summaries that documented the development of the snowpack from September through early May. Daily afternoon avalanche-hazard forecasts and morning



An avalanche incident killed three snowmobilers in the Snake River Range of Wyoming on February 27, 2009. Four riders descended one at a time from the ridgeline and were buried in a terrain trap by a slab avalanche that released from the slope on the right side of this image. Rescuers used explosives to trigger avalanches from the steep slope on the left side.

Photo by Gary Fralick

nowcasts were issued from early November through late April. The information issued by the center created awareness among our users that manifested itself into an unprecedented show of user restraint during the December/January avalanche cycle.

After several years of riding in clothing worn by backcountry skiers, our avalanche specialist donned snowmachine outfits obtained from Klim Technical Riding Gear. This breakthrough was the equivalent of putting on Gore-tex after skiing in jeans and cotton.

The center created a Professional Observation Network last summer. This network enables partner avalanche professionals to communicate and share snow, weather, and avalanche observations. This network went through a shakedown process and will be fully operational during the 2009/10 season.

Thanks to our partnerships with the Jackson Hole Mountain Resort, the Wyoming State Trails Program, and the generosity of sponsors, users, and the Annenberg Foundation we will employ two avalanche specialists on a full-time basis over the summer.

The Teton County Conservation District conducted Light Detection and Ranging (LIDAR) aerial photography over portions of our forecast area. This radar mapping technology produces high-resolution color images and digital elevation models (DEMs). The resolution of this project is 15cm for color ortho-photographs and one meter for DEMs. Previous efforts used DEMs with a 10-30m DEM resolution. The data generated from this project will enhance our ability to remotely define avalanche terrain and avalanche-path attributes such as slope angle, aspect, and curvature.

Over the summer our avalanche specialist will interact with remote-sensing specialists from the Geospatial Science and Engineering Team at the National Engineering Laboratory in Idaho to interpret and display data generated from this project, data from our network of automated remote weather stations, and to develop Google Earth type images of avalanche activity for display on our Web site.

—Bob Comey

Chugach National Forest Avalanche Information Center

What a big year for the Chugach National Forest Avalanche Information Center (CNFAIC). With the support of the Chugach National Forest, the Friends Group, and many supporters we reached more people than ever before. We had many changes and improvements this season that contributed to making the best and most accurate advisories so far.

The season once again started in October with early snowfall. As we put away the kayaks and pulaskies, we unwrapped new skis and gassed up the snowmachines. We also launched the new Web site. We've been able to get much more information out to folks about current avalanche, weather, and riding conditions, as well as a new maps page. The interactive nature of the Web site allows users to pinpoint their snow and avalanche observations onto a topo map, enabling us to see exactly where observations were made. The accident history map also allows us to read and learn from fatal accidents of the past.

The annual and free Fire Side Chats (avalanche-awareness talks) were once again held at the Glacier Ranger District. Attendance ranged from 25-65. We presented five classes, which are awareness level, and encourage all attendees to take a level 1 workshop.

Advisories started in earnest early November, when enough snow fell to get Turnagain Pass open for motorized use and allow good access through the alders to ski and board alpine slopes. High pressure and below 0° F temperatures in December and January faceted much of our early season snowpack. Below-average snowfall continued into March. The limited snowfall put manageable stress on a weak snowpack, keeping our avalanche hazard manageable. Mid-March provided a third of our total season snowpack and loaded slopes with enough stress to elevate our hazard for the rest of the season.

To add to the chaos, Mt Redoubt erupted on March 28 sending ash over much of south-central Alaska. March 28 also marked our first avalanche fatality. A snowmachiner was killed by a large avalanche (SS AMu R3 D2.5). The heavy load this storm put on our snowpack would be the most significant event of the season. It was responsible for very large avalanches across the Seward and Portage Highways. All the avalanches that covered the highways occurred during control work except for the Five Finger slide that hit the Portage Highway on April 11. A number of these avalanches were extremely large and ran further than previously recorded. Power lines and railroad cars were displaced as a result of this avalanche cycle, and backcountry skiers and riders were forced onto lower-angle terrain.

Earlier in the season the CNFAIC hosted and participated in an interagency training. On December 11, 12, and 13, members of the US Forest Service, Alaska

State Troopers, Alaska Mountain Rescue Group, Alaska Search and Rescue Dogs, Life Guard, local EMS, Alaska Avalanche School, and many volunteers participated in the avalanche-rescue training. These scenarios were set up with an operating ICS and active strike teams. During the training a call came in for an actual avalanche accident involving the complete burial of a skier in an adjacent drainage. After a 15-minute burial the skier was located and dug out alive by his party. The skier was 4' deep and was wearing a beacon.

The CNFAIC is very proud of this year's accomplishments, marked by significant growth and increased public support. This was accomplished by outreach, education, and advisories. We taught classes for the Chugach National Forest, Girdwood Communities Schools, Anchorage Parks and Recreation, Alaska State employees, and hosted five Alaska Avalanche School workshops. We were active partners with Alaska Pacific University professors and students. We were very lucky to have an exceptional intern from Evergreen University, Ben Faucher, who worked January through March and was instrumental to our field work.

The Friends Group sponsored the second round of observers training this year; 24 volunteer observers report observations back to the CNFAIC using Snow Pilot and our online observers page. The advisory covers terrain from Girdwood to Lost Lake. Turnagain Pass is the core area. This year we were lucky to get the assistance of the Seward Ranger District. Alex McClain, a Forestry Technician from Moose Pass was actively reporting snow observations from the Summit Lake area. We look forward to expanding our advisories accuracy and availability to the Seward Ranger District.

Looking toward 2009/10, we anticipate changing from five advisories a week to seven a week and extending the season until April 15, with the partnership and support of the Friends Group and continued support from the Chugach National Forest.

—Lisa Portune

Mount Washington Avalanche Center

New Englanders were chomping at the bit when the first appreciable snow of the season started to fall on Mount Washington in October. They dreamt of snow, talked about snow, and pulled out the fat boards that they purchased after the prior winter's record-breaking snowfall. Every snow ritual known to man was employed in hopes of something bigger than last year...chants, 5 laps around the table, ice cubes in the trees, spoons under the pillow, white PJs worn inside out, underwear in the freezer, etc. Fingers were crossed but the snow held off and then held off some more. We're still waiting.

The first real snow of the season hit our mountains when mom was shopping for the Turkey Day supplies. Unfortunately, like mom's apple pie, a thick crust concealed the goodies. The crust spoiled the plans for holiday weekend powder turns, but the optimistic New Englanders could be heard saying things such as, "At least she won't blow away," and, "Heck of a good base, let me tell you, mister man." We continued to receive only small helpings of snow for a couple weeks and didn't move from a General Advisory to a traditional 5-scale forecast until December 6.

One of the most influential weather events of the season commenced with a 60cm (24") storm on the winter solstice that was followed by sustained 161kph (100mph) winds. Windslab and debris beefed up many of our slowly maturing paths and then a rainstorm left some coal in our stocking on the night before Christmas. A 2.5cm (1") rain crust was formed; this layer haunted us for most of the season. Two months after its birth it was re-exposed in one area when a naturally triggered avalanche stepped down 2.5m and brought about the second coming of the Christmas Eve crust.

Each time a new crust was formed or re-exposed, it seemed to take an eternity to get it covered back up. After a typical November, every month provided below-average snowfall, and going into May we're close to 30% under what we should have received for the season. Liquid equivalents shared a similar deficit, and temperatures started cold before providing springtime averages warmer than the norm. Nonetheless we're currently enjoying the late spring with average coverage due to the absence of our typical January thaw.

The Mount Washington Avalanche Center has the unique responsibility of coordinating all search and rescue activities within our forecast area, and this year we dealt with 20 incidents. The winter's all-too-prominent rain crusts contributed to a handful of accidents in the form of uncontrolled sliding falls. On one memorable Saturday we were engaged in our annual refresher with our volunteer ski patrol when we received a report of an accident. Within 30 minutes two separate climbers in gullies a mile apart took sliding and tumbling falls over 300m (1000') long. Both patients were badly injured and required roped rescue techniques to get them to lower-angled terrain. The Mount Washington Volunteer Ski Patrol was critical in helping us get both of these individuals into ambulances in less than three hours from the time their accidents occurred. These volunteers contribute a total of about 200 days a season to help us out when the masses make their annual pilgrimage to the backcountry ski and snowboard Mecca of the East. They're a dedicated bunch with our oldest patroller Roger Damon currently working on his 70-year service pin with the National Ski Patrol!

On a busy Saturday in April the patrollers provided a hand when we had more than 2500 people visit our forecast area just after a late-season storm delivered 35cm (14") of high-density snow to Tuckerman Ravine. Increasing winds accompanied the snowfall until wind speeds held steady over 100mph for an eight-hour period. When folks arrived for a cloudless, windless day of spring turns, the temperature began climbing, eventually smashing the record daily high at the summit by 3.3°C (6°F). New windslab lost its tensile strength as the mercury soared and free water percolated down to lubricate a rain crust (surprise!) that served as a perfect bed surface. Three human-triggered avalanches occurred on adjacent slopes within a 90-minute period as skiers and riders continued to push farther and ignore bull's-eye data. No one was hurt during any of these avalanches (mostly D2-R2) despite having numerous people in the runout. In hindsight the snow science

is elementary compared to trying to understand the psychology of the people involved. Watch YouTube, and you'll see what I mean!

More than 20 avalanche courses were offered over the course of the season by local providers and the avalanche center assisted with almost all of them. Skiers and snowboarders have been the most common students and the number of climbers seems to have fallen off. To continue work with this user group the avalanche center once again cosponsored the 16th Annual Mount Washington Valley Ice Festival. We staffed an informational booth during the busiest period of the event and presented a multimedia program for the large crowd that attended the evening festivities.

By the beginning of May we've already issued over 150 avalanche advisories and it looks like we'll be going for a few more weeks. Hard copies of the advisory are posted at access points for the forecast area as well as around the valley at gear shops, guide services, and visitor centers. These posted copies are our primary method for delivering current information but visits to our Web site (tuckerman.org) continue to lead the way for those planning ahead. In April we had close to 90,000 site visits with noticeable spikes after well-publicized avalanche-related incidents. We had several successful experiences working with the media this season which allowed us to access a wider audience and set the hook for more folks to be reeled in to the Web site. Take a look, we dare you!

—Chris Joosen

PROFESSIONAL OBSERVATION FORM

Date: 2-25-09 Name: Janet Op: SHFAC
 Drainage/Route: Titus Ridge

WEATHER

Sky: X HNZ4: 10-15cm Temps: 20F & cool breeze
 Ridge/Wind: Light and gusty from the W
 Comments: Full cloud cover plus lower clouds at 10-11,000ft in AM. Visibility drops and snow begins by 1PM

AVALANCHE ACTIVITY

Date	Class	Type	Trigger	Aspect	Elevation	Location/Comments
Yesterday	2	SS	N	NE	9800ft	wind loaded cornice drop, possibly skier induced from ridge?
Yesterday	1.5	SS	N	E	9700ft	Walcher's wind loaded cornice drop SS & some loose snow

Comments: 2 small isolated collapses along ridge above 9500ft near wind deposit/facet crust areas. No cracking, wind deposits non-reactive.

GENERAL SNOWPACK STRUCTURE

Avg. Depth: Incredibly varied with exposure & elevation. 120cm 9,000ft 150cm 9,600ft
 Upper Pack: Shaded areas 30-45cm newer snow on old surfaces. Concerns for: F+ 13th buried facets on MF E,SE/facets on N
 Sunny aspects multiple crust layers/drier snow between no significant loads but some poor bonding upper elevations.
 Middle Pack: consolidated unless shallow depth hoar areas.
 Lower Pack: Shallow areas ind old slide paths= facets F-4F Others mostly rounds, 1F,P

STABILITY ANALYSIS

Primary Concern	Instability Type:	Confidence:	Depth:	Comments:
Persistent	Wind Slab	High	25-40cm	Comments: Q1 shears, multiple tests from 9,000 to 9700ft. Skin up area from lake low angle 25 to 28 degree sites-ECTV, ECT 11 30-40cm deep F+ broke on facets on thin MF. Other SE sites 9000-9400ft easy Q1 shears on F/MF but ECTN 13, ECTX 25-30cm deep.
			30-60cm	Comments: "Wind Deposit" not a wind slab problem. Concern is for enough snow to load facet layers where crusts are absent and snowpack less reactive but still poor structure. Stability tests in sheltered sites indicate not enough load. ECTN 23 Q3, 40-45cm deep NE, ECTX 30cm deep facets NW. Walcher's area indicates activity resulted from just a bit more loading by wind. Whether it was a skier yesterday or wind knocking the cornice drop off it didn't take much to produce two separate, decent size slides. W facing too wind swept/drifted or variable to get good information from 9,900ft to even down by Ego slope 8,700ft. I searched pretty hard but didn't find crust/facet combos here they may be elsewhere on W, WNW.

Marked with checkmark if observed:

Natural Avalanches	Collapsing (isolated)	Precip Loading
Triggered Avalanches	Collapsing (widespread)	Wind Loading
Persistent Weak Layer	Cracking (isolated)	Warming
	Cracking (widespread)	

BOTTOM LINE

E,SE with crust facet interface CONS danger where 30cm or more on steeper slopes.
 N and NW do not have MF and need additional load from wind or heavy snowfall areas to be CONS danger but steep slopes appear not to be trusted.
 S,W uncertain as to bonding of recent snow, need more obs but appear to not have facets at interface in a number

An example of the observations on the Professional Observation pages implemented this season by the Sawtooth National Forest Avalanche Center.

Sawtooth National Forest Avalanche Center

In south central Idaho, the winter of 2008/09 was marked by long dry periods followed by two to three weeks of sustained snowfall. This "famine and feast" pattern was a good recipe for creating – then burying and overloading – persistent weak layers. It ultimately resulted in several dangerous avalanche cycles.

The first drought lasted into December. By early that month only 2" of snow had accumulated at the highest elevations, and the snowpack totaled just 30-50% of average. Bitterly cold temperatures arrived in mid-December, and soon the shallow snowpack consisted mostly of unsupported depth hoar.

Winter turned up with the solstice. A rapid progression of storms blasted the area from December 21 through January 2, bringing 65" of snow and 5.4" of SWE to Galena Summit. Some storms were as generous with the valleys as the mountains; on Christmas morning we recorded 26" of new snow at the ranger station, nearly equal to the total on Baldy. Thanks, Santa!

That rapid load was too much for the basal depth hoar, and a widespread natural avalanche cycle occurred on upper elevation, shady slopes. We began issuing daily avalanche advisories on December 22, the latest ever, rated the hazard as High for nine of the next 12 days, and broadcast avalanche warnings twice during that time. Fortunately – from a safety perspective – difficult backcountry travel limited the number of people in the mountains, so we had few reported incidents.

The next drought lasted six very long weeks. A few teaser storms swept through but dropped just 2.8" of SWE around Galena Summit and a mere 1.3" on Baldy. The snowpack stabilized, and people enjoyed recycled powder, along with a few days of supportable, spring-like conditions. For the drought's last week we rated the hazard as Low at all elevations on all aspects. By then, however, the near-surface

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layers of the snowpack had weakened dramatically, although the weaknesses showed a high degree of spatial variability.

Those weak layers were first buried on Friday, February 13, earning them the moniker "The Friday the 13th layer." Snow then began accumulating steadily, with Galena Summit recording 35" of snow over 12 of the next 20 days. The weak layer's spatial variability meant stability differed widely among slopes and on individual slopes. Like a scary movie, the tension built as a bluebird weekend passed with no incidents. The storms culminated in 13" of snow and 0.9" of SWE on March 4. Two days later, a party of four skiers near Galena Summit triggered a large avalanche; sadly, one skier was killed and a second seriously injured.

The storms during this time left less snow near Ketchum – just 37". But the snowpack structure in this area was just as weak, so by March 18, after another 20" of snow and heavy wind deposition, it too was overloaded. An isolated but spooky natural avalanche cycle occurred over the next few sunny days; it involved many large avalanches, some triggered remotely. Fortunately, no one was caught.

Winter stayed well past the spring equinox, with a series of cold windy storms dropping another 42" of snow and 4" of SWE near Galena Summit in the last 10 days of March. Lower elevations and areas further south received much less. December 1 to April 1 snowfall totaled 210" near Galena Summit, leaving our snowpack at 87% of average.

We continued to receive reports of natural and human-triggered slides the last week in March, after we'd ended daily advisories for the year, so we posted updates with special concerns. Temperatures finally warmed on April 4 and 5, but the rise was dramatic, as single-digit lows climbed into the mid 40s for the first time since January. On April 5, a snowmobiler triggered a large avalanche while high-marking in steep, rocky terrain. He was buried 4' deep and could not be resuscitated. It appears the avalanche ran on the Friday the 13th layer, and we remain concerned about Friday the 13th layer until the snow is gone.

The SNFAC had a busy education schedule during the 2008/09 winters, reaching over 700 people with varied backgrounds and experience levels.

- **2-hour Avalanche Basics presentation:** We split our standard education program into "skills" and "application" sections. Dividing it helps students learn to recognize avalanche conditions and then apply this knowledge in the backcountry.
- **Snowmobile-specific education:** We developed a snowmobile-specific version of our avalanche basics class that did away with any skier-oriented photos and video and has an optional Saturday field session. Chris and Blase also assisted the Idaho Department of Parks and Recreation with the field portion of a snowmobile class outside of Fairfield.
- **Spanish-language education:** The City of Ketchum circulated our "Viviendo y Trabajando en Zonas des Avalancha" bilingual avalanche-awareness flyer to local businesses and snow-removal services.
- **Youth-education:** Sara Lundy taught a well-received 45-minute "Know Before You Go" program for 100 7th grade students at Wood River Middle School.
- **A convergence of snow nerds:** A grant from the Wattis-Dumke Foundation enabled us to hold an extremely successful panel discussion titled "How does avalanche research help Joe Backcountry?" (see TAR 27/4). Four internationally recognized avalanche researchers headlined the event, presenting their latest research and fielding questions from the audience.

Other Accomplishments:

- **Professional observations Web site:** To improve information sharing among area operations, we developed a Web-based professional information exchange that proved remarkably successful. SNFAC, Sun Valley Heli Ski, Sun Valley Trekking, Sawtooth Mountain Guides, and Sun Valley Resort submitted over 200 observations. Integral to the professional Web site is a weather page that lists links to weather stations and forecasting data.
- **Online, interactive avalanche-safety brochure:** We developed an online, interactive version of an avalanche-safety brochure we created two winters ago. Because it is built in Adobe Flash, it can be incorporated into other avalanche center Web sites. Currently, it is accessible through our Web site and Avalanche.org.
- **Advisories:** We added danger roses to our advisory format.
- **Crossing the 100,000 milestone:** Use of our advisory continued to increase, despite dry conditions much of the winter. We documented over 101,000 advisory accesses.
- **Funding:** In spite of challenging economic times, we have been able to maintain consistent, diverse partnerships and enthusiastic local support, which we consider a sign of doing the right thing.

For the first time, the SNFAC had three full-time staff for most of the winter. I arrived in mid-December, Lead Forecaster and Web Maestro Chris Lundy returned



The SNFAC forecast team (l-r): Chris Lundy, Blase Reardon, and Janet Kellam.

for his fifth season, and Director Janet Kellam finished her thirteenth. We pride ourselves in maintaining a state-of-the-art operation, despite the small size of our center and our budget, and continue to help move our profession forward and increase the effectiveness of avalanche advisories.

—Blase Reardon, forecaster



The stage is set at Alpentel for the next act in the ongoing northwestern avalanche opera.

Photo by John Stimberis

Northwest Weather and Avalanche Center

The 2008/09 winter season as a whole in the Pacific Northwest can be characterized as a play with a prologue followed by three dramatically different acts: THE PROLOGUE, THE MUCH, THE LITTLE, THE MUCH MORE!

THE PROLOGUE

The play begins like many that have come before. Under-funded, but snow begins to accumulate in early November anyway as winter enthusiasts hopefully anticipate yet another big season. Mt Hood accumulates 30" of snow by November 5. But wait: this avalanche opera is set in the Pacific Northwest where the stage can quickly change. Indeed it did on November 12 when some 3-6" of rain arrived in a day ruining all those carefully arranged sets. Many stage hands abandoned the project and it took another month before the production could begin again.



In early January, a huge mud, snow, and slush flow at the Hyak ski area on Snoqualmie Pass halted operations for the rest of the season. "In a nutshell, the chairlift that was damaged by the event has been completely removed and quite a bit of grading work has been completed to restore the damage done down below the release zone," reports Rob Gibson, regarding Hyak's status for this winter ski season operations. "The release area itself has been re-contoured and smoothed but will not be filled back to normal slope character this year in order to see what drainage and subsurface water issues remain. There were some indicators of quite a bit of subsurface water channels in the area and it needs some further evaluation.

"The damaged chair is intended to be re-used (less one tower) on the backside of that particular mountain, and another spare lift is meant to be installed on the front side to access the terrain the damaged one used to, but due to spending constraints, neither of those projects was approved this year.

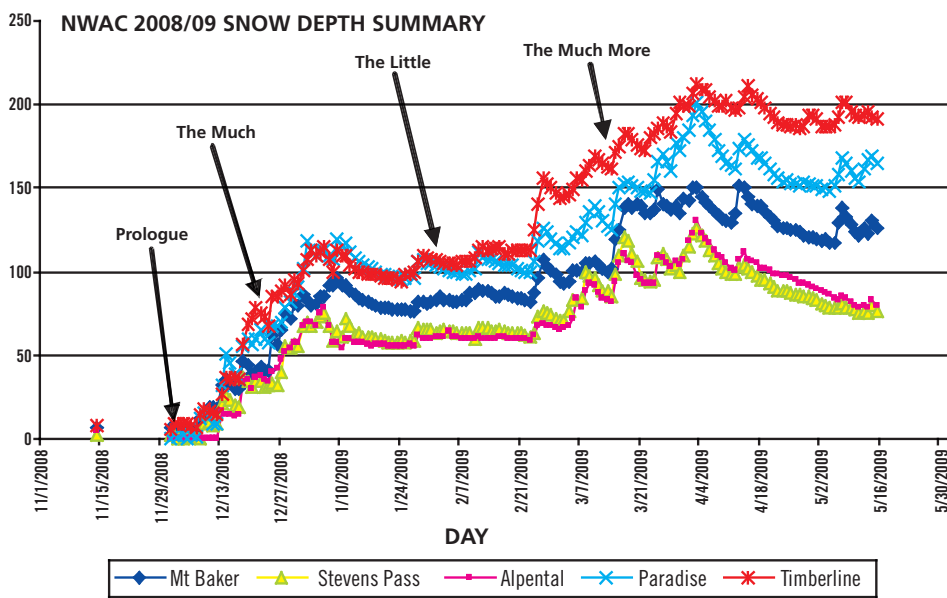
"Hyak is also our Nordic system base of operations, so Hyak will operate this season in that capacity – snowshoeing and Nordic – with some limited base-area facilities. There is also a beginner lift at Hyak and a fixed grip double (pretty short), but management has not decided yet whether they will operate those lifts for guests this winter or not. Hyak has several condominium buildings and a medium-sized residential development adjacent, so there is some pressure to run the ski area in a limited capacity." *Photos by John Stimberis*

THE MUCH

On December 12, the freezing levels plummeted and snows began to blanket the stage in earnest. By Christmas, Mt Baker had received 100" of new snow and Mt Hood over 140". Freezing levels remained extremely low through this period with multiple snowfalls covering Seattle in a deep white, a rarity in these parts. Most ski areas opened around the 13th or 14th of December with epic, deep, cold snow.

The very cold temperatures through late December not only deposited lots of low-density snow, but weakened and faceted the pre-existing shallow snowpack, as well as the November rain crust basal layer. The deep unconsolidated snowpack that had developed by late December set the stage for the inevitable soprano's entrance. She was big, heavy, and loud – once she started in, there was no letting up. Between Christmas and January 6, most areas received an additional 7-8' of snow at warmer but still relatively cold temperatures by Northwest standards.

As "she" was set to come on stage, the warnings went out. We warned folks of the dangerous developments that were on the way, and many heeded the warnings. Despite the warnings, on December 28 Washington recorded its first avalanche fatality when a snowmobiler was buried and killed after triggering a large slide near Hart's Pass in the North Cascades. The group was untrained in avalanche safety, although they had a plan to accommodate the conditions,



then failed to stick by it. After leaving the safety of the lower-angled and treed terrain after not seeing any signs of instability, the group of four snowmobilers decided to test the steeper slopes above tree line and on a loaded northeast-facing slope, all were riding on the slope at the same time when it released. Numerous other close calls were reported in the same area that weekend.

Brunhilde was singing loudly now, but not as loud as her encore was to be. Freezing levels climbed to over 8000' on January 7. Between the January 6 to 8, most areas had received 6-8" of water with Snoqualmie Pass recording over 11" over those two days, causing some massive activity, including a true ground failure and full-depth mixed mud, rock, and slush slide that took out several lifts at the base of the Hyak ski area at Snoqualmie Pass, forcing the area to remain closed the entire season. The big rain produced the biggest reactions of the season and, in some cases, 20 to 30 seasons. The rain crust left behind from this event remained a benchmark in the snowpack for the remainder of the season.

A few of the many log entries:

- Highway closures—I-90, SR542, US12, US2—due to avalanches, mudslides, slush/debris flows, etc.
- Large avalanche from Excelsior (second slide of the series) punched through timber and deposited 20' of debris on State Highway 542, then turned and ran down the road.
- Confirmed first-hand slide in Wenatchee Bowl near Stevens Pass ski area from storm. West-aspect 5600' slide went to just above ground on old firm layer from November. Failed on facets above that ~25cm above ground. Avg crown 7' max 8' class 4.
- Varden Ridge in the northern Washington Cascades went R5 to the ground, crown at west summit of Silver Star looks close to 3m, #14 was at treeline and was 180cm deep.

Following the "big sing," Brunhilde left a few morsels of snow as things cooled, then the big dame left the stage well before her frenzied fans were satisfied. In typical diva fashion she kept them waiting...and waiting!

THE LITTLE

The willing left in attendance were unsatisfied by the basically unsuitable conditions for enjoyment in the backcountry as deep wet snow gradually refroze and turned into a death crust. Next, oddly enough, a big ridge raised the freezing level to above 13,000' in mid-January with two full weeks of dry weather. Following the ridge, a strong split flow developed in the eastern Pacific, directing storms towards California into late February; most completely missed their usual mark on the region. The combined snowfall totals for January and February equaled about what was received the last three weeks of December. The story that had begun with some real promise had become quite dull. The spectators had become restless, calling out for the slumbering Brunhilde to return to the stage. A glimpse of her was caught in the wings the last few days of February. She appeared in full, the word spread, and soon the throngs were clambering to the hills once again.



Shuksan Arm near Mt Baker, Washington, March 20, 2009.

Photo by Lief Hazelet

THE MUCH MORE!

Aria after aria rang through the mountains... the final act had begun. March proved to be the biggest month of the season. Freezing levels averaged about 2500' with snowfall amounts averaging about 140" along the Cascade west slopes for the month of March. The second fatality in the Northwest occurred during this stormy period in the Wallowa Mountains of northeastern Oregon, outside the forecast area of NWAC. A party of three skiers was caught, two totally buried, one partially. One recovered alive, one not. A warming event around March 18 to 20 produced a big cycle, especially in the Mt Baker area with some rather impressive slides. Another log entry tells the story.



Brunhilde swoons after an epic March aria in the Pacific Northwest.

- Crown on Shuksan Arm is 3-4' up to 8' by a half mile, all knobs released, mostly filled valley with debris up to a half mile below. Yesterday afternoon north side of Herman slid 4-8' x 400 yards. Pit today at Austin Pass 2-3' storm snow over 4" F snow over hard rain crust from last week.

Cool showery weather prevailed through much of April; most areas reached peak snow depths in early April. Strong cold upper trough passages in early May deposited some 3-6' additional snowfall, producing a secondary maximum in snow depths and requiring several special statements to cover the warming and sunshine that followed these storm cycles. The final act appears to be winding down now in mid-May, as freezing levels should reach their highest levels of the spring at around 14,000'.

—Kenny Kramer, NWAC forecaster and amateur opera enthusiast



Bill Glude of Alaska Avalanche Specialists sees some results from helicopter mitigation along the Snettisham power lines.
Photo by Mike Bartholow

Southeast Alaska Avalanche Center

As the smoke from the Alaska Department of Transportation (AKDOT) 105mm Howitzer settles on the Gastineau Channel this sunny April day, I start to gather my thoughts for TAR Season Roundup 2008/09 article. With over 4.3m of snow currently on the ground at our local snow-study plot and nearly that much in our mountain starting zones, the season is anything but over.

It has been an interesting year for the Southeast Alaska Avalanche Center (SAAC). Late last spring the city of Juneau lost power due to a huge avalanche that downed multiple towers along the Snettisham power line corridor (see TAR 27/1). This event renewed interest within the community in regard to avalanches and avalanche safety. Since then the power company hired Bill Glude at Alaska Avalanche Specialists (AAS) to run a season-long forecasting and mitigation program for them. Last fall the City of Juneau, the primary funding source for SAAC, decided to hire an avalanche forecaster to create urban avalanche forecasts for the community. The avalanche forecaster's other responsibilities include community education, working with local search and rescue groups, and fundraising for avalanche-related projects. At that time Bill Glude, the SAAC executive director, decided to step down, and the SAAC Board of Directors chose to mothball the center and stand by in hopes of working with the city in a "friends of" capacity in support of the city's new avalanche program.

Juneau has a unique location, dramatic topography, and coastal weather patterns with the potential to create the largest urban avalanche disaster in the United States. The city has 62 houses, one hotel, two sections of expressway, two sections of state highway, eight residential streets, and a boat harbor all located in avalanche zones. The difficult part of creating an accurate forecast here is the huge spatial variability in the region and very limited weather data for the areas of concern. It is also quite difficult to access starting zone elevations in the rugged mountains without a helicopter. This distinct urban setting provides challenges that foster the need for a cooperative forecasting program.

Upon my arrival to Juneau in November I realized that in order to create a forecast for the urban areas I would need to gather data from various places around

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the region. Three entities currently work full time within the region's avalanche terrain, creating avalanche forecasts and performing mitigation as needed. AKDOT also performs mitigation for the Thane Road in town via the 105mm Howitzer and yet has no forecaster. I immediately approached the area's specialists: Brian Davies, Eaglecrest Ski Area director of snow safety; Jamie Pierce, Kensington Gold Mine avalanche safety director; Bill Glude, owner of AAS working on contract for Alaska Electric Light & Power; and Greg Patz, chief of maintenance and operation for AKDOT with the goal of getting them cooperatively involved in the avalanche center to share data within the region. After conferring with Juneau City Manager Rod Swope, I decided to offer my services to the SAAC in order to create a regional avalanche forecast. Shortly thereafter I was appointed as the executive director for the SAAC.



Mike Bartholow, AAA secretary, hard at work as a visiting forecaster for AAS on the Snettisham power line mitigation project. *Photo courtesy Mike Bartholow*

During the course of this winter the City and Borough of Juneau (CBJ) and SAAC have participated in multiple training exercises. Eaglecrest Ski Area hosted a multi-agency, hands-on avalanche-rescue exercise that included participation from groups such as SAAC, Capitol City Fire and Rescue (CCFR), Eaglecrest ski patrol, Juneau ski patrol, Juneau Mountain Rescue (JMR), Southeast Alaska Dogs on Ground Search Team (SEADOGS), Juneau Snowmobile Club Rescue Team, and the Kensington Mine avalanche safety team. CBJ held an urban avalanche tabletop exercise for all department directors and city EMS providers. SAAC, AAS, and CBJ provided multiple training sessions including tabletop exercises for CCFR. CBJ and SAAC participated in multiple field training days with outside search and rescue groups such as SEADOGS and JMR. SAAC provided a companion rescue lecture for the Juneau Snowmobile Club. CBJ and SAAC also held community neighborhood discussions about the avalanche danger and protocols for periods of high danger. The community is making great strides in its preparation for a major avalanche disaster.

To fulfill our educational mission SAAC provided awareness courses for the general public throughout the region. We were fortunate this year to have Eaglecrest professional ski patroller Jason Kohlhasse donate his time to deliver a community-wide awareness program to our fifth grade classes. Bill Glude of AAS continued teaching SAAC-offered level I and II courses through UAS as well as a heli-guide course through Alaska Heliskiing.

Southeast Alaska was blessed this year to have one of our best snow seasons on record. Eaglecrest Ski Area recorded 446.1" of snow this season, nearing their previous record of 469.65" set two years ago. The region saw long periods of consistent cold weather and excellent stability with very few exceptions. From mid-December to early April there were only three events that brought above-freezing temperatures and extreme avalanche hazards to our starting zone elevations. On January 12 we saw our first big warming trend that brought rain to the upper areas of the mountains causing the Snettisham power line to once again be downed by an avalanche. The low ceiling and poor visibility created "no fly" conditions that prohibited mitigation efforts. In February AKDOT was caught by surprise when a natural avalanche crossed and temporarily closed Thane Road. During the last week of March we experienced another period of high instability with no major notable events. We had a few near misses in the region with backcountry skiers, snowboarders, and snowmobilers taking unwelcome rides in avalanches, but all things considered, it was a safe and amazing winter.

The Southeast Alaska Avalanche Center is already looking forward to next season. We have planned two city-wide awareness programs for school children. The National Weather Service will be donating its time to teach an introductory level awareness course for the younger kids, and the SAAC will be teaching an upper-level awareness course for older students.

It has been a year of great change and renewed energy here in southeast Alaska. *—Tom Mattice*

Utah Avalanche Center - Wasatch

General happenings and highlights of the Utah Avalanche Center

Bruce Tremper, Evelyn Lees, Drew Hardesty, and Brett Kobernik continued to staff the Salt Lake office, Toby Weed ran the show in the Logan office, Craig Gordon held down the Western Uinta office, and new-hire Grant Helgeson ran the operations on the Wasatch Plateau.

- Craig and Grant's *Know Before You Go* (KBYG) program reached several significant milestones this year. It's now been seen by over 100,000 Utah teens. Not one Utah teen attending a KBYG presentation has been killed in an avalanche. This year the Utah Board of Education included KBYG in the Health One Core Curriculum, a class taught primarily in the 7th grade. Recco and Backcountry Access came on board to help us with our message.
- A \$50,000 budget shortfall was nearly met through a unique partnership with many of the ski area resorts, facilitated by Ski Utah and Backcountry.com and modeled on a successful program at the Sierra Avalanche Center in Truckee. Ski areas donated lift tickets to our 501c3 nonprofit, Friends of the Utah Avalanche Center, that were then sold online at a discount to the public. The ski areas received increased awareness as supporters of the UAC, pro-bono avalanche education and support, as well as a tax break. Skiers and boarders looked at it as a donation to the UAC with a day's lift ticket, and the Utah Avalanche Center recovered most of the shortfall. We look to continue this partnership for years to come.
- We taught Level 2 avalanche courses, and Craig taught a snowmobile-specific Level 1 in the Uintas.
- We utilized Google Earth and Google 2D maps to visually and spatially display locations of accidents, avalanches, snow profiles, weather stations, and more.
- We put the final touches on a project called *Avalanche Ratings for Selected Routes in the Central Wasatch Range*. We modified the Canadian Avalanche Association/Parks Canada Avalanche Terrain Exposure Scale, customizing it specifically for the Wasatch. Thirty popular Wasatch routes were color coded (green, yellow, orange, red) based on interaction with avalanche potential. A *Route Decision-Making Matrix* soon followed to help users decide which terrain may be appropriate for them on any given day, based on their education, experience, and the day's danger rating. This tool is intended to be utilized as an at-home planning tool. (see TAR 27/3)
- Toby developed a pocket card for use "on the snow" based on red flags in the snowpack and terrain.
- Brett is on the cusp of utilizing the new Drupal software in order to revolutionize online observations into a Web-based columnar and spatial display of searchable database.
- Alta received over 700" of snow for the second year in a row, 200" over their yearly average.
- We suffered four avalanche fatalities – our running 10-year average. Fatalities included three snowmobilers and an in-bounds skier at Snowbird resort.

Early season, deep-slab instability kept us walking on eggshells through the middle of January, but a record-breaking spring made us forget all of our early winter woes. Of course each winter is characterized by the snow and wind – but it's the stories that we remember, as they are the defining moments that characterize the season. The following are some of the stories from the winter, with some taken directly from our forecasts (many appear as actual journal entries):

Oct 4, 2008: Forecaster Brett Kobernik fractures his femur, his MCL, and his ACL in a dirtbiking accident in Southern Utah. Not good. The welder-come-forecaster reinvents himself as another Bill Gates by learning the Drupal content-management system and transitions our Web site with Dharmatech to a cutting-edge, content-management system.

Oct 15, 2008: We transition to the Drupal Web site and a Google virtual office that enables forecasters to issue forecasts, receive observations, update all Web products, and create web calendars and documents from any remote site with internet access.

Nov 1, 2008: First Utah Snow and Avalanche Workshop with over 300 in attendance. Topics range from deep-slab instability to explosive use to wet snow and is taught by many professionals with over 20 and 30 years experience in the business.

Nov 12, 2008: Rain to all elevations.

Nov 29, 2008: Rain to all elevations. Not good. Will henceforth be dubbed the Thanksgiving Rain Crust. And a few other unpublishable terms.

Location: Argenta Slidepath, Kessler Peak Big Cottonwood Canyon

Aspect: North facing Elevation: 9800'

Date: 12-29-08 Hardesty

This widespread structure plagued Utah and much of the West through December into early January.

Thanksgiving rain crust

Mid-Nov rain event

F 4 1 P K

(Softer snow → Harder Snow)

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Dec 10, 2008: A backcountry skier remotely triggers a slide into old snow, collapsing the November 29 rain crust on the weak faceted snow underneath. It rips out 70' away from him, pulling out 10" deep and 70' wide, running 200'.

Control teams along the Park City ridgeline are also getting slides to collapse the rain crust and pull out into the older faceted snow beneath. They appear to be the exceptions and not the rule now, but with storms lined up for this weekend and beyond, these are a portent of things to come.

Dec 14, 2008: It didn't take long. A tragic accident occurs inbound at Snowbird Ski and Summer Resort. A 27-year-old woman is killed in an avalanche on a steep, northwest-facing slope on Baldy around 10,500'. She's buried for 50 minutes and found by probe line. This turns out to be the first of four inbound avalanche fatalities this winter throughout the West – a new record.



This natural avalanche ripped out on Square Top, in the Park City area, in December. It engulfed a previous avalanche path that was triggered two weeks earlier by a skier who was injured in the slide. *Photo by Jake Hutchinson*

Dec 17, 2008: These are the conditions that can catch and kill people. No, we are not having a widespread natural cycle. No, we are not seeing more snow and blow. ***But this is where you and the snowpack intersect on a line of desire and instability*** that will produce the accident. Buried land mines lurk everywhere at the mid- and upper elevations on many parts of the compass. When collapsing is the rule, remotely triggered avalanches are the rule, and snow-safety teams are shaking their heads while talking about 20-year events, one must pause.



Craig Gordon of the Utah Avalanche Center points out the repeat offender rain crust from November. *Photo courtesy UAC*

Dec 18, 2008: I would like it more if we just had a blockbuster storm with plenty of snow and blow and just be done with it. This would produce a widespread natural and human-triggered avalanche cycle, and then maybe we could start again. Instead, we're seeing snow and wind in dribs and drabs – making it locally unstable here, but you might be able to get away with it there. It's too much. The snowpack is thin, weak, and fraught with multiple failure planes and issues. Most of the hullabaloo surrounds the weak faceted snow above and below the rain crust, but a fair amount of the activity over the past couple of days has initiated a few inches above in some thin faceted snow, only to collapse the crust and step into the older weak, faceted snow.

Dec 23, 2008: Yesterday a friend of mine along the Park City ridgeline triggered a slide that broke 40' above him, releasing 2-3' deep and 50' wide. He was able to grab a tree and let the snow wash by. But that wasn't all. Skiing out to the left, he had another piece of snow break out 100' above him. He was just able to ski into a tree and again hold on as the snow rushed by. He was uninjured, but he lost a couple years to his life by the event.

Dec 24, 2008: *Come, let's go
Snow-viewing
Till we're buried.*

—Matsuo Basho, Japanese poet in the late 1600s



Two young snowmobilers triggered this huge unsurvivable avalanche near Logan Peak, Utah. *Photo by Toby Weed*

Be careful of what you wish for. The wheels are coming off. Remember our old analogy of putting the *Encyclopedia Britannica* on the kitchen table and tilting it up to 40 degrees? The same thing is happening here, except as the book slides away, the table legs are breaking off too.

We suffer our second and third fatalities in a single, large, triggered slide that kills two snowmobilers near Logan Peak. With little to no rescue gear, the two locals, age 22 and 23, stood no chance under the onslaught of the 4-7' deep and 2000' wide avalanche. They were buried 6' and 10' deep, respectively.

Control work at the ski areas continues to produce larger and more radical avalanches, with some taking out old shot holes, wrapping around ridgelines, and failing – moving down the slope a few feet, thinking about it, then releasing to the ground and running full track. Some release high on the slope, mid-slope, low on the slope, and generally west to north to east – and not confined to the highest elevations. This is one of the many stories from yesterday: a patroller skis out onto the slope to put an explosive that is duct taped to a piece of bamboo in the starting zone. He skis off to the side, remotely triggering a hard slab 3-4' deep. He looks back to see the stick-bomb shaking from the slide. Then it explodes, taking out the flank of the other slide. This dislodges a boulder gouged into the ground which rolls downhill on top of the debris.

Getting out of the way at the bottom is not the same as it used to be. If you get out of the way and move under an adjacent avalanche path, the next rider may remotely trigger that slide on top of you. I am convinced that remotely triggered slides have and will continue to save lives. It has saved my own. The unsuspecting rube collapses the slope and avalanches out the slope(s) he was just about to center-punch.



An example of one control shot at Alta initiating a crown that spreads across the landscape. *Photo of East Greeley from the Alta Web cam*

Dec 26, 2008: Full burial and live recovery near Little Water Peak. This is a place people go when they're spooked, since most slope angles are less than 35 degrees. This 4' deep, 100' wide hard slab was triggered by the third person on the uptrack, at point with a steepness of 29 degrees. The fracture line had one small area that measured 33 degrees with the rest at or below 30 degrees. Fortunately, the others have practiced deep burials and have the blue victim out within 10 minutes. (*see story on page 31*)

Dec 29, 2008: A 15-year-old snowmobiler perishes in another deep slab avalanche – this one in the Western Uintas. It measures 4' deep and 600' wide and was triggered remotely by another member in the party. No one has rescue gear. Add the following to the forecast to adjust popular perception regarding some avalanche victims:

- ***They were experienced.*** They may have skied or snowmobiled for a few years, or ridden the slope before, but that doesn't translate to an understanding of the dynamic processes of snow and avalanche formation. You can't get a job as a sommelier after drinking a couple glasses of wine.

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The deepest section of the Yamaha Hill crown, which caught another young snowmobiler, this time in the Uintas, December 29, 2008. *Photo by Craig Gordon*

• **They were prepared.** Saying you're prepared with your beacon, probe, and shovel in these conditions is like saying you're prepared with a life jacket as you're going over Niagara Falls.

Dec 30, 2008: The war-zone that is the Wasatch Range looks a checkerboard of crown lines and barely hanging-on pieces of snow. There's this idea going around that we're out of the woods. A few days ago, it was *certain* you would trigger an avalanche. Now, you might get away with it. But it's more likely that you won't. Even the savviest have used up all the tricks in their bag and are reduced to skipping along slopes in the mid-20-degree slope angle range or walking ridgelines. Looking at avalanche sensitivity as a bell curve, I'd argue that it's most dangerous not at the apex but along the sides of the bell – on the side where conditions start to deteriorate as well as on the other side where they appear to improve. Because it's not all about the snow. It's about us.



Note the crown on Peak 10,321, outside of the Brighton boundaries, just above the avalanche warning signs these guys ignored, skiing with no beacons, probes, or shovels. They were very lucky indeed to escape with their lives. *Photo by Curt Gwilliam*

Jan 7, 2009: Why do they call it a persistent weak layer? The above photo of another very close call in Brighton's out-of-bounds backcountry says it all.

Feb 17, 2009: Words cannot describe the onslaught of snow. With another 1-4" overnight, storm totals since Monday night are 28-32" in the Logan and Ogden area mountains, 24-28" in the Cottonwoods and Provo mountains, and 16-18" in the Park City environs. 6.5" of snow-water-equivalent at the Ben Lomond snotel site is unbelievable. Long-running naturals take out mature timber and cross North Ogden Divide.

Feb 24, 2009: A slow day in the office. Then the phone rang: "Large natural! North facing! Up by Snowbird," which set the gears in motion for LCC UDOT to hunt for the slide and set me thinking I had blown the forecast (this n-e-v-e-r happens). What follows is a wild goose chase, a media feeding frenzy, and then ribbons and medals for Little Cottonwood Canyon's Finest: "Drew called us this AM about a few reports of a slab avalanche, north facing near Snowbird. After a confusing half-hour search we located the culprit on the north side of the bypass road running down into the creek. We carefully approached the hang fire and made our way down to the bed surface despite being yelled at by the local inhabitants from a distance. "Not a good idea guys! Hey guys – not a good idea! Don't you know that's a terrain trap?" After identifying ourselves, the warnings subsided. Rough estimates were 3' deep by 50' wide running full track (150') on a NNW aspect and 36-degree slope. The slab was as abnormal as anything I've ever witnessed and is definitely not in the SWAG guidelines – a mixture of 1F, pencil, and knife – looking much like asphalt or something you climb in Maple Canyon, a conglomerate slab with ice chunks, road material, and everything else that gets picked up by a front-end loader doing its morning rounds. We had a difficult time pinpointing the weak layer as it was hidden in the form of what we usually think of as rounded, strong, snow-density inversion. Standard stability



The most unusual avalanche of the season, on a road cut near Snowbird. *Photo by Adam Nesbitt*

tests were useless, given the entire column would fail within itself, fracturing in every which way possible – vertically, horizontally, diagonally – you name it. A little disturbed by the whole experience, we settled on a theory of rapid loading without prior sufficient compaction. We dubbed this new avalanche path "Public Nuisance," rated the avalanche CS-AO-R3D2-O, and agreed this was the most interesting avalanche of the season.

After hearing the report and seeing the photos, I posted a full gallery on the Web site entitled, *Alta Avalanche Study Center Discovers New Avalanche!* Things were pretty slow at the avalanche office. The media blitz that followed was unbelievable: TV, newspapers, and radio wanted (and got) interviews, photos, historical significance, etc. (They never did pick up that it was mostly a joke.) When the UDOT head honchos caught wind of the activity, they called to personally congratulate our DOT colleagues on "continuing in the finest spirit of tradition," and each received formal letters of recognition in their government file.

Mar 10, 2009: It stops snowing. Heat wave. Wet avalanches. The ides of March effectively place a dagger into the heart of the winter. It doesn't snow for two weeks. Alta sits at a measly 445.5" and temps soar into the 50s at 10,000'.

Mar 16, 2009: Strange avian happenings in Logan. Forecaster Toby Weed and partner happen upon a young, injured golden eagle which they ski out of the backcountry for professional rehabilitation.



Unfortunately, the eagle later died of liver failure. A few weeks later during a storm, a lone and disoriented brown creeper attaches itself to Toby during another field outing. It crawls onto his hand, up his sleeve, peers into his mouth, roosts on top of his head, then flies off.

Mar 22, 2009: It starts snowing again – and snows 14' in 14 days, a record two-week snowfall in upper Little Cottonwood. Snow totals through April 17 are 231" / 17" SWE. Deep-slab instability asleep. With surface or mid-pack weaknesses, avalanche cycles run on schedule with the storms. Backcountry skiers and riders wait a day and then hit the steep lines with impunity. Ski it if it's white.

Mar 24, 2009: *The fourth day of spring-
Japanese cherry blossoms
can fend for themselves*

When the stars align – the moisture, the cold air aloft, the orographic support... Storm totals, now with another 6" overnight, are up to 28" of cold smoke in upper Little Cottonwood.

April 17, 2009: It stops snowing, but only for a few days. Another 3' deluge arrives the following week, followed by a return to spring, warm temps, and the peeling off of wet layers. Large, destructive, size 4 glide avalanches rip out in Stairs Gulch, followed by other significant climax glide releases.



Another April glide avalanche, this one in Broad's Fork. *Photo by Wendy Wagner*

By season's end, Alta recorded 680" of snow, we suffered our average of four avalanche fatalities, hits on the Web site exceeded 1.7-million views, and most of the UAC staff scattered into the four winds by late April. —Drew Hardesty, forecaster

Little Water Avalanche from the Inside

Story by Tom Diegel

December 26, 2008

Little Water Peak, Wasatch Range, Utah

On December 26 I left the Mill D lot solo and skied a run with a ton of other people on Tom's Shoulder/Wuthering Heights. The skin track began a few hundred feet down canyon from where it usually starts, but I decided to follow it until I didn't like it anymore – if indeed that happened. But it seemed to be okay, and a quick pit (in addition to what someone else had done) on the steepest roll indicated that the new snow, at least, was relatively stable. Of course, it wasn't the new snow that everyone was worried about; it was the near-ground crust/facet/crust/facet/ground silliness that was now pretty well loaded. However, that line is low angle enough that I felt it was unlikely to slide, as did the rest of the 10 to 15 people on that slope.

En route I hooked up with Matt, Dan, and Paul, all of whom I bumped into in the backcountry at one time or another. At the bottom of the Tom's Shoulder shot I decided to head up canyon and see what else could be had without the hordes about, and Matt, Dan, and Paul followed. When they caught me, they invited me to join them going to Little Water, which sounded like a fine idea. Not super-inspiring skiing, but nice for a day with high danger and surprisingly fast-skiing snow.

We ascended the west ridge of Little Water Peak, noting that the south sides would probably make a nice exit – exposed terrain, but due to its southern aspect (dirt two weeks ago and mostly windward yesterday) and relatively low angle, it would probably be fine.

We stopped to de-skin prior to the top of Little Water Peak, having bypassed the first knoblet that offered super mellow, aspen-glade skiing, anticipating that we would return to ski that on a subsequent run. En route we found a nice, steeper leeward pillow on top of a short slope that we used as a test slope, and nothing moved. The northeast face of Little Water Peak is a steep "frequent flier" shot, and even though the adjacent slope that goes due north is a lot lower angle, we



Matt and Dan stood in this spot when the avalanche broke. The slope measures 29 degrees here, but the crown face is 32 degrees and 33 degrees in places below the crown face.

Photo by Bruce Tremper

were content to stop well short of that one as well and simply drop into the thick trees very directly from the flank with no exposure.

We skied probably 800-900' of bouncy fun powder in tight trees and re-congregated again in the flat drainage. The plan was to take the skin track generally trending climber's right (skier's left) in order to have convenient access to the many different glades in that area. I started breaking trail from the bottom with the intent of warming up a little (<10°F) before stopping for a drink and a snack. As I ascended I was trying to move more climber's right, but the early snowpack-induced thicker trees/bushes, and my desire for a nice skin track pulled me a bit more up and left than I have done in the past and more so than the other guys had done in their previous outings there.

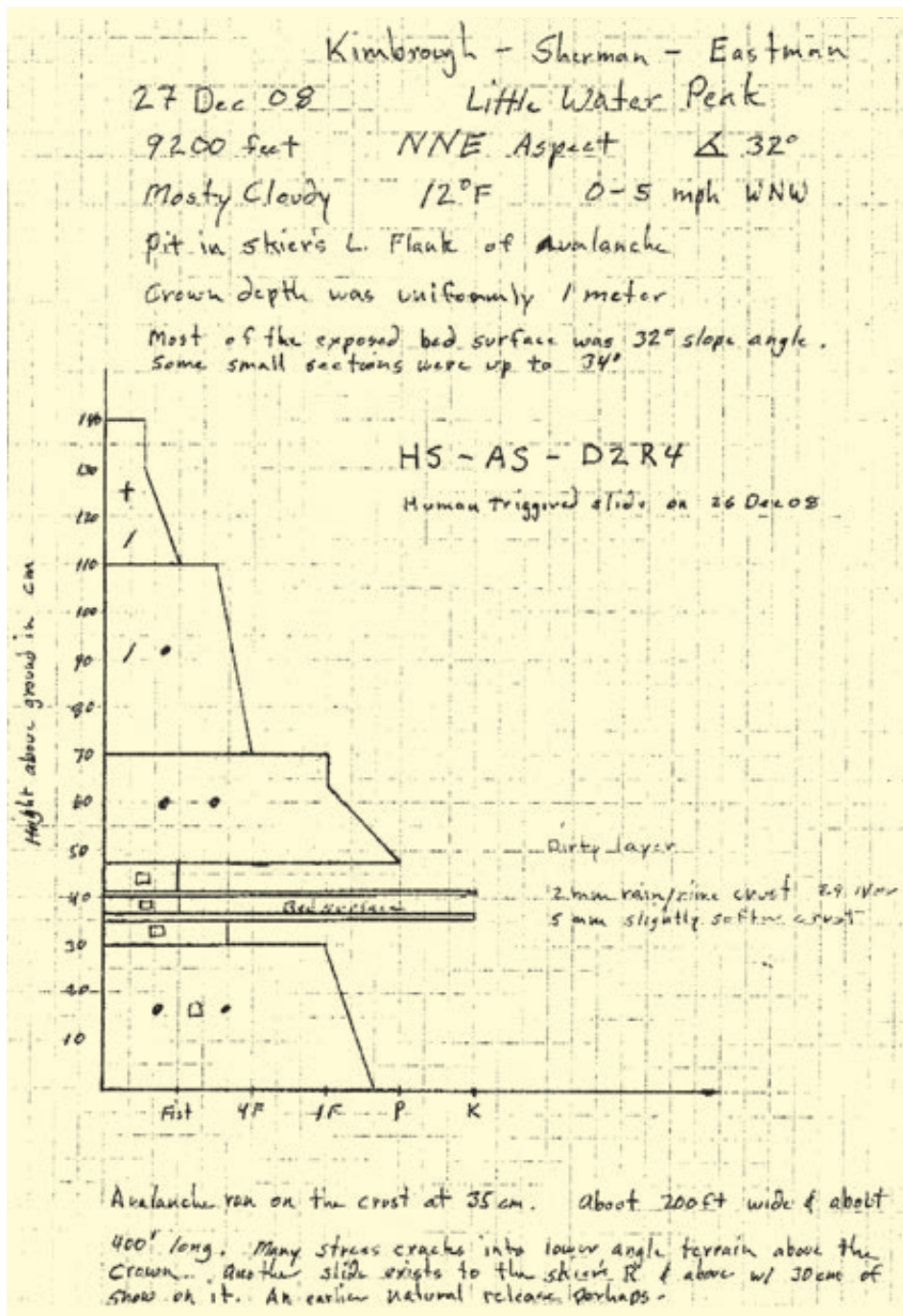
I finally popped out at a better spot to move right, but it was an open slope. In the past we had skinned below this open slope on flatter terrain in bigger trees, but that's not where we ended up. The reason we were in Little Water is that the slope angle is generally quite mellow, and looking at the open shot in front of me I guessed that it was at most 30 degrees. We were probably 400 vertical feet below the ridgeline, and I felt that crossing it one at a time would be safe. I moved across it, and at the other side – in the lee of a tree where the slope dropped to perhaps 20 degrees – I stopped to watch Paul cross the slope. He got to me and kept going on past to assume the small low-angle ridge and use that as the remainder of our climb. I looked back as I munched my sandwich to watch Matt and Dan come across. As Matt took one step out of the trees, suddenly there was the telltale whumph, and the slope shattered as a 4' crown opened just behind me. It propagated up into the woods above Matt and Dan, and I could see it moving through the trees. I yelled for Paul, turned around, jumped off the crown onto the bed surface, and skied down to where I had last seen them. I could hear Dan yelling but no Matt. I went to receive on my beacon, told Dan to do so as well, and also told him (asked politely?) to get out his shovel and probe.

We were within a few meters of Matt almost immediately, but the beacon indicated that he was at the foot of a very large tree with lots of live and dead branches extending down into the snow. The debris had piled up fairly high on the tree and its associated picket fence. When we were less than 2m on the beacon I started probing and hit him almost immediately. Despite the presence of the ground and the many logs/branches, I knew instantly that I had hit him; it was quite a distinctive sensation. Although I remembered the theory of digging to a victim from the down-slope side, because of the tree we could not do that, so our only choice was to go straight down. We had two of us going on him while the third cleared snow from the trench we were creating that was perpendicular to the slope. Matt was somewhere around 4' deep, but because the snow that was around him hadn't moved very far it hadn't heated up from friction and gone to concrete, so we were able to dig somewhat effectively, though the conical nature of the hole due to the tree was frustrating.

We finally hit his head, which was vertical. As we tried to clear the snow from his face I heard him moaning softly, which was encouraging. We kept trying to clear snow away, but it was difficult because of the snow continuing to fall into the airspace. When we could, we tried a finger sweep of his mouth, but his jaw seemed fairly well clamped shut. He was no longer moaning at this point, and as his face came into better view he was quite blue and unresponsive. Finally I was able to bend down and give him a couple of rescue breaths and had no response. I went down again for another couple breaths, and as I did so I saw his eyes flutter open, and he took a breath on his own.

From there it was just a matter of continuing to dig at about 98% rather than 125% in order to get him out of the snow as fast as possible. It took about 10 more minutes to release him from his skis and haul him out. He was able to converse and guide us to the most effective spots to dig in order to extricate him. Once out, he was able to stand on his own, but he was shivering near uncontrollably. We put lots of clothes on him; poured a bunch of hot, milky, sugary tea down his gullet; and soon we were hiking out and Matt began to warm up.

We were at about the 8900' level, due-north facing, slope angle in the 27- to 30-degree range. The slope was about 120' wide and maybe 200' long, and didn't run very far at all due to the flatness below. Total vertical drop of the entire slope was maybe 50 vertical feet. The previous day's storm had dropped about a foot of snow after very strong (~40mph) winds that were mostly southwesterly. As we skinned up we saw that another open slope above – with a noticeably steeper pitch – had slid some time



From Tom Kimbrough re Little Water slide
Salt Lake City, Sun Dec 28, 2008

A couple of us checked out the Little Water slide today. Spooky - spooky - spooky... Especially the burial site. The rescuers (contrary to rumor, I was not there) did an very good job.

NNE aspect 9200' elevation. Most of the exposed bed surface measured 32 degrees with a few small spots up to 34. Crown height uniformly one meter. Much of the slab remained partially intact with cracks through it. Estimates of size: 200' wide by 400' long. It released in small facets between the ubiquitous crusts, running on the lower crust. A few small sections of the bed surface did run on the upper crust.

There is another very similar slide up and observer's left of this avalanche that appears to have released naturally late in the last storm.

Watch your steps and turns out there boys and girls. Tom K

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Robbie Hilliard. Photo by Joe Royer.

Every second counts...



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previously since there was new snow on the crown/bed. Because there had been no reports of this, and so few people were out on Christmas day, we were almost certain that it had released naturally. We hadn't see that slide on the way up since we ascended the ridge out of sight of it. Had we seen it, it's possible that I would have made a different route choice for our ascent.

Once we were all safe and sound, the reflections began. The decisions, in chronological order:

- **Ski today at all versus not:** high danger day.
- **Where to ski - macro:** Mill D is considered "safe," with some very obscure exceptions or a fair bit of effort to get into more radical terrain.
- **Whom to go with:** I was solo, and the other three guys have clearly skied together a lot. We came together easily as a pretty natural group – I watched them, talked to them, felt they were pretty solid, and apparently they felt the same about me. Four is definitely a fine party size, and I think that had Matt only had one partner, he'd be dead due to the fact that the three of us worked well and efficiently together yet were only barely able to get him out in time.
- **Where to ski – micro:** We all felt comfortable with the decision to ski the northwestern slopes off Little Water Peak – low angle, lots of trees, very little exposure.
- **Skinning and ascent route:** We discussed the macro plan, but – as usual – the trail breaker chose the route. They were content to follow my track, but if they had not, I would have totally respected their decision. I did not ask Paul who came behind me what he thought of the skin track nor of my decision to cross the slope.

Fundamentally, there are a lot of ways to ascend that area without exposure to any open slopes. In retrospect, of course I should have stuck to the unexposed areas as I was in charge for that portion of the trail breaking. I have skied that area probably once a year for the past



Matt photographs the hole where he lay buried 4-6' deep just two days earlier. Digging through tree branches made for a tricky recovery. *Photo by Bruce Tremper*

couple of years and don't know it as intimately as I know some other areas. I didn't realize until later that at least a couple of the guys had been there just a couple of days before, so they had a better sense of the terrain. Being a little cold and having a love of trail breaking initiated my charge up the trail.

With regard to the rescue, I was very pleased that Ashley (my partner) and I make a big deal out of our beacon searches being more like rescue practice – instead of simply putting a beacon under a few inches of snow, we bury a pack as deeply as we can. The deep burial has the potential to be confusing with digital beacons, and on the day of the accident

we started to get a little confused by the fact that our beacons were only getting us to about 2m. I had the tickle in my brain from our practice experience with mock deep burials that indicated to me that we needed to get off our 2D plane, start going down, and at the 2m point probing would become crucial.

In addition to practicing deep burials, we also take the time to create an avalanche-looking area, making sure that deployment of the shovel and probe happens, and a dig ensues. This is accompanied by annoyingly loud reminders of how much time has passed and an occasional geeky pop quiz about how to apply CPR once the "victim" had been uncovered. This type of detailed practice made the concept of executing an actual rescue that much easier and provided confidence that the applied rescue actions were appropriate – despite the intense pressure of real-life implications. I also think that practice helped me concentrate on the rescue execution rather than allowing fatalistic thoughts ("He's gonna die," "How am I going to live with myself," "How will I tell his wife," etc.) to sneak into my head.

Matt's reflection on his down time echoed those that I've heard in the past: absolutely cemented in place, feeling panic but trying to squelch it and relax, getting dreamy, not having much of a sense of time, then hearing the voices. Fortunately, Matt seems to be an unusually mellow character, which probably helped preserve him until we could assist.

He was not using an AvaLung pack, but given the super short ride (he probably only "rode" 10 horizontal feet) it's debatable whether he could have gotten it into his mouth.

Tom Diegel has been skiing since he was a wee lad in Oregon. After a hiatus of getting into kayaking (due to poor skiing in Oregon), then living in the NE (ditto) and SoCal, he came to Utah 10 years ago and has been charging around the backcountry and learning from avalanches ever since. He is a partner in a company that designs, develops, and tests (primarily) outdoor gear. ❄️

