THE Avalanche REVIEW

A Publication of the American Avalanche Association

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www.AmericanAvalancheAssociation.org

FREEZE FRAME

story & photos by Bill Nalli

Provo Canyon, December 14, 2009

Like our winter in the Wasatch, this slab at Sundance just doesn't want to get up and go. A shallow snowpack with depth hoar abounds. What we lack in great skiing we seem to be making up for with interesting avalanche conditions. After our second real storm of the season, most slopes throughout the range have approached their critical load. Many have avalanched naturally, but those that haven't are tempting the stoke-deprived masses. There are many reports of cracking and huge collapses along with sympathetic and remotely triggered avalanches. These shots look like they are a frame grab from a video of a moving avalanche. It really only traveled 30' before it stopped. The trigger was a snowcat on the ridge before the grooming happened. The slope angle ranges from 28 to 33 degrees, and it failed 30" deep at 2-4mm facets at the ground.

Bishop's Bowl covers about 50 acres of terrain and is located at the upper reaches of Sundance Ski Resort.

Based on tensile cracks found at both flanks and all the way at the bottom, the entire bowl collapsed and moved a few inches downhill. Funky. These conditions make me wish for a different type of start to the season, one where it snows early and keeps on coming.

Bill Nalli is a UDOT forecaster for Provo Canyon.

for more on Provo Canyon, see page 20

The Avalanche Review
P.O. Box 2831
Pagosa Springs, CO 81147

in this issue

As I started running, I took two steps and fell through the breakable wind crust up to my waist. I remember thinking, "You gotta be kidding me. Did I really just fall as the monster is chasing me through the forest?"

—Bill Nalli, *Remarkable Sightseeing*, p20

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from the president — Adapting to the Times

The Sawtooth forecast team (l-r): Chris Lundy, AAA and avalanche.org webmaster; Blase Reardon, AAA publications chair; and Janet Kellam, AAA board president.

Let's face it; we live in a fast-paced world and challenging economic times. The avalanches don't care about that, but they do care about an equally dramatic change to their environment. Long-time avalanche professionals are routinely facing unusual conditions. The Northwest was at 300% of average in the early winter while Idaho was facing a record dry November. As I write this in early December, Houston, Texas, was marveling at 4" of snow on the ground, and my backyard at 6000' in Idaho only had an inch or two.

Participation at the fall professional development seminars was impressive in the attendance, in the quality of presentations, and in the discussions and information taken home and shared among those who could not attend. SWAG has been updated; the 2009 edition is available now from the American Avalanche Association Web store at www.americanavalancheassociation.org/store.html. A number of informal, local avalanche workshops are cropping up, and avalanche pros are developing ways to communicate and share timely information among their peer work groups. Outfitters, avalanche centers, ski areas, educators, and highway snow safety providers are all helping each other in many ways as we face ongoing changes to our work environment and our working conditions.

The goal of AAA is to facilitate opportunities that benefit you and your avalanche programs. Our efforts began more than 20 years ago when Sue Ferguson initiated *The Avalanche Review*. This publication continues to bring us timely, informative, and often thought-provoking articles. An ever-growing circulation gives proof to the success of TAR.

We will continue to publish and promote TAR as well as move forward with our internet based programs: www.AmericanAvalancheAssociation.org and www.avalanche.org.

These avalanche Web pages provide a single go-to resource of current information, opportunities, and programs for the avalanche professional. As you read this issue of TAR, the new AAA Web pages will be online, cleanly integrating with avalanche.org.

We need your help! In order to communicate effectively with our membership we'd like to be able to reach you with our e-newsletters. (We also would like to eliminate the waste that accompanies multiple postal mailings each year). We sent out an *Avalanche News* e-letter in late September 2009 and found that it did not reach many of you. Please send us your current e-mail through aaa@avalanche.org or the contact link on our Web pages. And please note: we respect your privacy; we will never distribute your e-mail address. So please, help us help you!

AAA is doing well and has some solid programs. Now is a great time to get involved. Check with your section rep or a governing board member about possibilities. *—Janet Kellam, AAA president*

Editor Lynne Wolfe and Rod Newcomb discuss hardness differences in the snowpack on the last day of an AAI level 2 in December, on top of Glory Bowl, Teton Pass. *Photo by Josh Parker*

from the editor

I stayed home last night and had dinner with my husband and three friends whom we have known since the '80s, having pieced the night together from five complex schedules. Now this is nothing newsworthy, but when our old friend, Jackson Hole ski patroller Mark "Big Wally" Wolling died after being avalanched, his service was also scheduled for last night. We discussed it at length and made the difficult choice to spend the evening in our smaller group, to connect and mourn and celebrate in private. That evening, we talked about things that mattered, we laughed long and hard, we toasted Big Wally with a promise to carry on his "work," since he no longer can. He was a spark in every aspect of his community, someone who touched many others in many ways – all of them positive. Wally was in the front line of the pros battling this year's incarnation of the deep-slab, hard-slab problem that we continue to focus on in TAR.

We didn't get to hear the bagpipes and the poetry, to share hugs and more than a few tears, but we hope that, in our way, we celebrated our friend's life with distinction, and we each resolved to transmit Wally's spark in meaningful interactions in our own communities. Look for an obituary of Mark "Big Wally" Wolling in TAR 28/4.

The Avalanche Review is a big part of my community involvement; I am committed to the broad-brush goal of keeping people from dying in avalanches, and to the more specific goals of educating, connecting, and "poking/prodding" our snow and avalanche community. In this issue, 28/3, you'll see one example of your editor "stirring it up" a bit. Doug Abromeit generously wrote up his presentation about in-bounds avalanches from the last few years along with some musings and conclusions. I took his article and asked a couple of class-A ski area snow-safety veterans, Craig Sterbenz of Telluride and Scotty Savage of Big Sky, to elaborate on their strategies for managing the deep-slab problem at a daily level. *(see pages 26-28)* I strongly believe that my role as TAR editor is to make connections and get people talking to one another about the questions we are all wrestling to define and answer. Thanks to the many snow professionals who graciously accept my queries for information and my requests for their opinions and photo stashes. What are you pondering this winter? What strategies have evolved for your team?

Provo Canyon is the scene of a close-up look at past and present evidence of dramatic terrain, which this year, thanks to El Niño, sports the same unsupported structure as much of the West. We'll see more photographic evidence of El Niño's resultant depth hoar regime producing a wave of carnage around Christmas in TAR 28/4. John Snook agreed to write an understandable version of the complexity of El Niño and other Pacific oscillations; Wendy Wagner and Leigh Jones translate his theory and examples into questions and insights for this winter. *(see pages 16-18)*

In another terrain focus, Peter Carse leads us through the risk and terrain management steps that led to the opening of Bridger Bowl's new Schlasman's lift. I appreciate Bridger's Bowl's approach to personal responsibility and risk management: "We are striving to be on the carving edge of snow science in our ongoing exploration of the 'human factor' as it relates to personal responsibility, with inbounds extreme terrain as well as side-country decision-making." *(see page 24)*

Bridger has always required its Ridge riders to step up; now even lift riders must learn and practice a more backcountry-oriented set of habits from the usual. It's a good example of management and community rising to the occasion.

There's much more in this issue of TAR: some science, some news, some whimsy such as Eric White's Christmas forecast, and finally some incredible photos. I sent out a call for photos and was rewarded by some tremendous images: people, avalanches, terrain, even art shots in black and white from Garrett Grove. Now I have such photographic richness that we'll continue showcasing these in TAR 28/4.

Finally, I want to heartily thank Mike Richardson of Scenomics.com for deconstructing the huge and ponderous TAR digital files into single pdfs of each article; these will soon be available, organized by issue on the AAA Web site. Look for an index by topic somewhere down the line, but each article is already titled with the author's last name, the issue number, and a general topic name (e.g., decision-making), making them easy to find in a search. Mike volunteered for TAR to make a difference in our snow community. We can all find a role if we look for what fits. *—Lynne Wolfe*

The Day Before Christmas

Poem by Eric White
from Avalanche Advisory 12/24/09, Mt Shasta

'Twas the day before Christmas and all through the peaks,
Not a slab was sliding, avalanches were bleak.
The snowpack had settled in and appeared to be strong,
but when I dug down, I realized that was wrong.
I studied the layers with thermometers and scopes,
And performed stability tests with only good hopes.
As the data came in, and I looked to the ground,
A weak layer persisted, which I previously found.
What to my wondering eyes should appear?
A layer of facets and depth hoar – it was clear!
But I felt a little better when I tested the snow,
As it took a lot of force to get it to go.
So, travel the slopes with respect and due care,
And remember on steeper slopes to always beware,
For under the snow surface you just might find,
Persisting weak layers of the worst kind!

metamorphism

Matt Dayer is pleased to fill Denny Hogan's BLM/FS Snow Ranger job for the San Juan National Forest.

San Juan Snow Ranger Matt Dayer

The American Avalanche Association thanks the following members for contributing an additional donation to further our efforts in 2009. Donations totaled $18,560 and amounted to 17% of our total income in our fiscal year 2008/09.

BENEFACTORS ($1000+)
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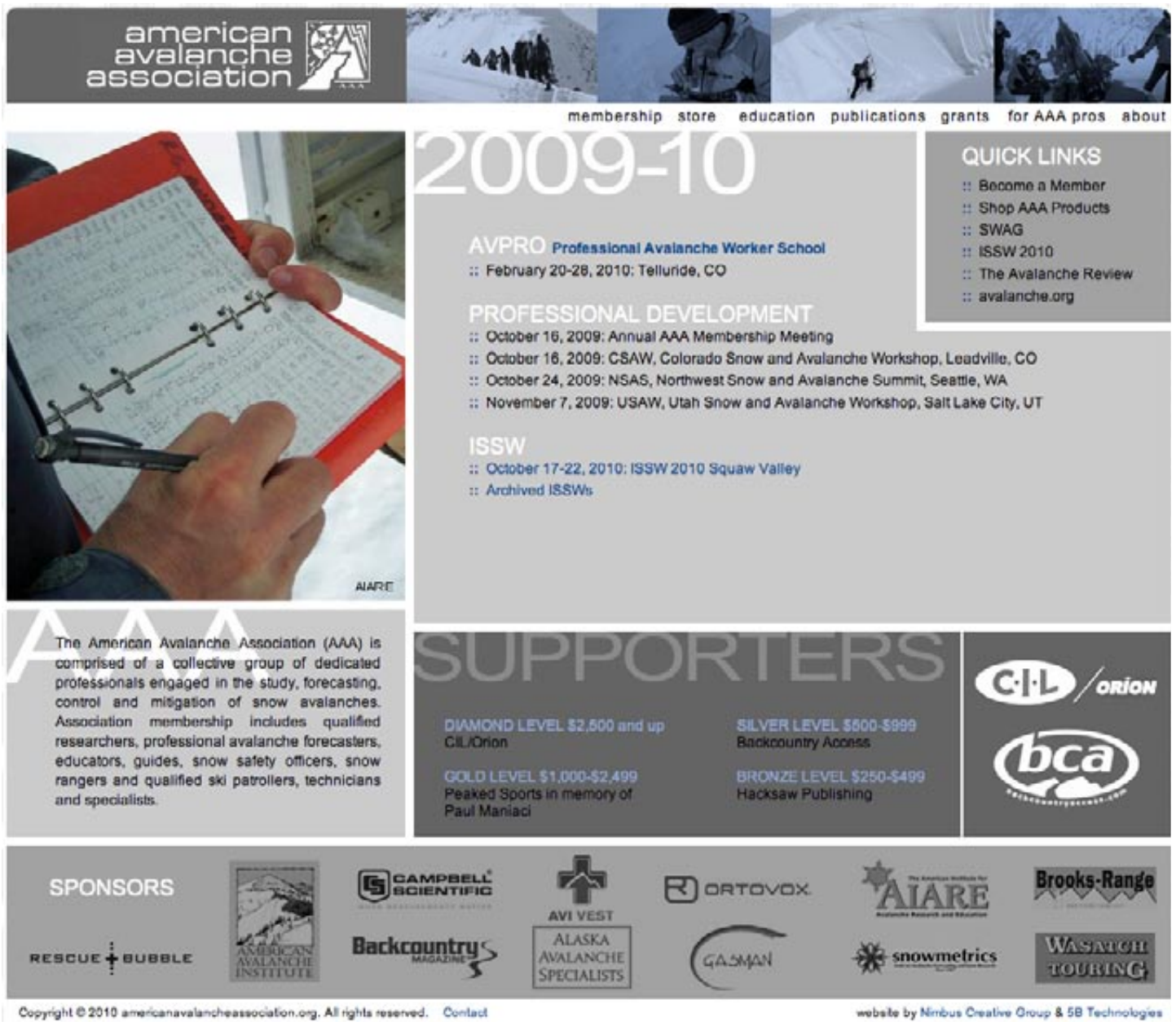
Gary Murphy
Linda Helms
Karl Birkeland
Nathan Kerr
Mark Renson
Zachary Slutsky
Matt Kinney
Richard Mullowney
Scott Quirsfeld
Prescott College,
In honor of Rod Newcomb

Congratulations to our newest **AAA-CERTIFIED INSTRUCTORS:**
Paul Baugher, Enumclaw, WA, and Santiage Rodriguez, Boise, ID

aaa news

CHECK IT OUT!!! AAA Upgrades Site

The American Avalanche Association recently launched an updated Web site featuring new graphics, new links, and an updated look. The new layout will mesh with avalanche.org and will be easier for AAA members to find information about programs, grants, membership, and professional news.



ISSW 2010 October 17-22

The Resort at Squaw Creek Lake Tahoe, California

Early Registration/Room Packages *(by April 30, 2010)*

Registration $150
Deluxe Guestroom ..... $143/night *(sleeps 2)*
Fireplace Suite..... $161/night *(sleeps 4)*
Deluxe Fireplace Suite .... $179/night *(sleeps 4)*

Early Registration w/o room $225

Regular Registration/Room Pkgs *(May 1 – September 1, 2010)*

Registration $200
Deluxe Guestroom $159/night
Fireplace Suite..... $179/night
Deluxe Fireplace Suite $199/night

Regular Registration w/o room ... $275

Late Registration/Room Packages *(after September 1, 2010)*

Registration $300
Deluxe Guestroom $159/night
Fireplace Suite..... $179/night
Deluxe Fireplace Suite $199/night

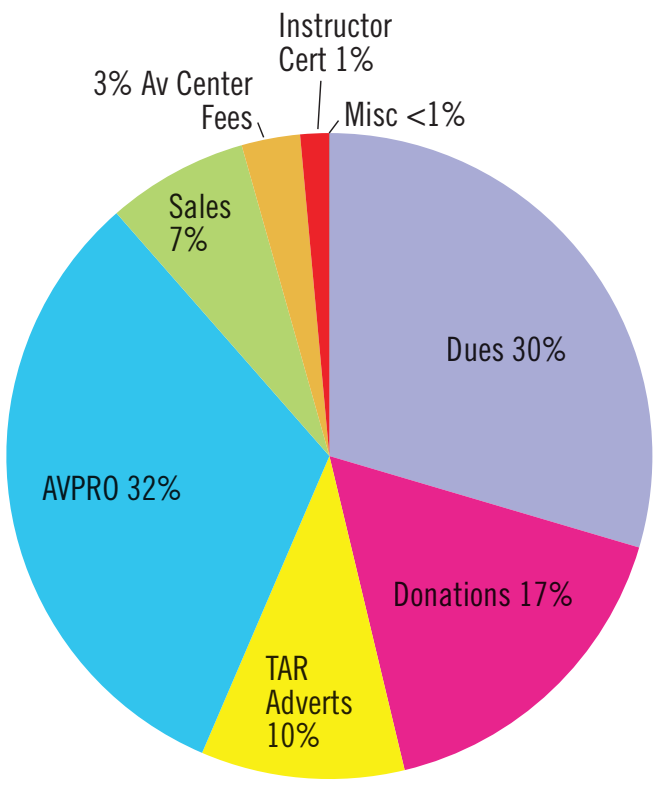
Late Registration w/o room $350

Register at **www.ISSW2010.com**

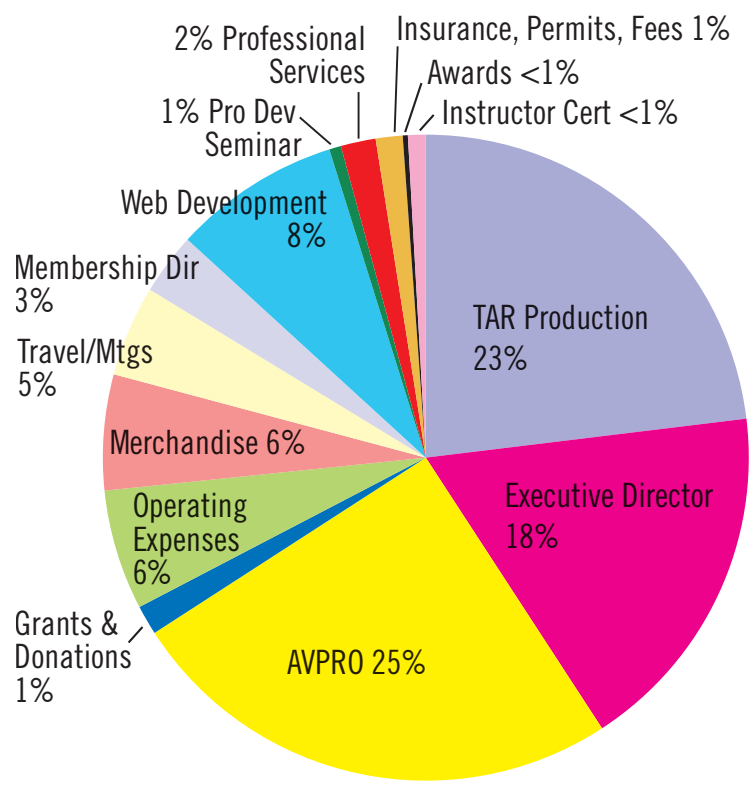
All ISSW participants who book a room at The Resort at Squaw Creek have access to free transportation to and from Reno International Airport and free shuttles in and around the local Tahoe area.

For more info, contact Lel Tone at 530-412-1496, Lelctone@yahoo.com Box 3445, Olympic Valley, CA 96146

AAA INCOME 2008/09



AAA EXPENSES 2008/09



AAA INCOME 2008/09

ITEM	INCOME	%
Dues	32,892	30
Donations	18,560	17
TAR Advertising	11,339	10
AVPRO	35,700	32
Sales	7,869	7
Avalanche Center Fees	3,261	3
Instructor Certification	1,600	1
Pro Dev Seminar	0	0
Miscellaneous	13	<1
TOTAL	$111,234	

AAA EXPENSES 2008/09

ITEM	INCOME	%
TAR Production	23,414	23
Executive Director	18,000	18
AVPRO	25,426	25
Grants & Donations	1,500	1
Operating Expenses	6,108	6
Merchandise	5,872	6
Travel/Meetings	4,615	5
Membership Directory	3,137	3
Web Development	8,500	8
Pro Dev Seminar	600	1
Professional Services	1,775	2
Insurance, Permits, Fees	1,366	1
Awards	258	<1
Instructor Certification	900	<1
TOTAL	$101,471	

what's new

CAIC Forms Friends Nonprofit, Benefit Bash Goes Off

The country's largest avalanche center has taken it to the next level with a brand-new Friends group and a record-breaking fundraiser. The Colorado Avalanche Information Center (CAIC) now has the support of the Friends of the CAIC, which raised over $35,000 at their benefit bash held in Breckenridge on November 14. That's a 40% increase over net proceeds from the year before and more than twice as much as was raised at previous Avalanche Jam fundraisers on Colorado's Front Range.

This year's CAIC benefit event raised 40% more than the previous year, raising a banner $35,000 for the avalanche center. Over 1000 people attended the bash.

The new Friends group was prompted after bureaucratic hassles resulted in the cancellation of the seventh annual Avalanche Jam in 2007. The cities of Golden and Boulder, Colorado, resisted permitting the fundraiser because CAIC lacked 501c3 nonprofit status. Event organizer Backcountry Access (BCA) used 501c3 certificates from the American Avalanche Association and the Roaring Fork Avalanche Center (now a part of the CAIC) to obtain the necessary permits. But in 2008, the city of Boulder flatly denied the application. The event was saved by Breck locals Aaron Carlson and Joe Vandal, who put together Benefit Bash 2008 in Breckenridge last November. That event was a huge success and led to this year's record-breaking attendance of over 1000 people, despite complications from a heavy snowstorm.


l-r: Breckenridge residents Aaron Carlson and Joe Vandal organized the CAIC benefit event this November. Nice ties, guys.

Additional smaller-scale events in CAIC epicenters have put the group's 2009 revenues near the $45,000 mark. Those were held at Bent Gate Mountaineering in Golden, Neptune Mountaineering in Boulder, Pine Needle Mountaineering in Durango, and Sheridan Opera House in Telluride.

The Friends of CAIC established a board over the summer, comprised of retired long-time CAIC director Knox Williams, former Roaring Fork Avalanche Center co-founder Lance Lary, and BCA co-founder Bruce Edgerly. CAIC director Ethan Greene is a non-voting board member. At a meeting this fall, the board appointed Carlson as executive director and Vandal as director of development. Carlson and Vandal have since created a Web site (www.friendsofcaic.org) and built an extensive social media campaign.

The main objective of the Friends of CAIC is to provide financial support for the CAIC's backcountry forecasting program (the CAIC's transportation forecasting program is supported by state funding). A secondary objective will be to support avalanche awareness programs and research in Colorado. Board members are currently researching avenues to support avalanche awareness programs for youth in Colorado's mountain communities.

"Aaron and Joe are exactly what we needed to get our fundraising off the ground," said CAIC Director Greene. "Their efforts will directly translate to better backcountry forecasts, more outreach, and greater avalanche awareness in Colorado."

"I couldn't think of a better way to spice up my retirement," added Friends Board President Williams. "I'm looking forward to staying involved with the CAIC, even if it cuts into my time on the golf course." ❄

name: Micayla Fay Shefftz
gender: It's a girl!
date: December 26, 2009
time: 1:13am (yes, oh so close to a Christmas baby)
weight: 7 lb, 2 oz
height, er, make that length: 19"
mondopoint boot size: 8.5
vertical her father got the day her mother would be admitted to the hospital: 13,800'
foregone vertical:
I could definitely have gotten in another 2k before the lifts opened at 4pm!
elapsed time between when her father changed out of his rando race suit to when her mother was admitted:
Uhh, I think it was pretty much simultaneous.


Proud parents Jonathan and Andrea Shefftz snuggle with baby Micayla Fay.

Rollin' With The Dogs

Author Kevin Marston goes to work with his avalanche dog Hannah. *Photo courtesy BARK*

Story by Kevin Marston

What comes to mind when someone mentions huckleberries and a hot summer day? Probably not an avalanche dog, but this was the scene for Kevin Huggett and his dog Bazuka.

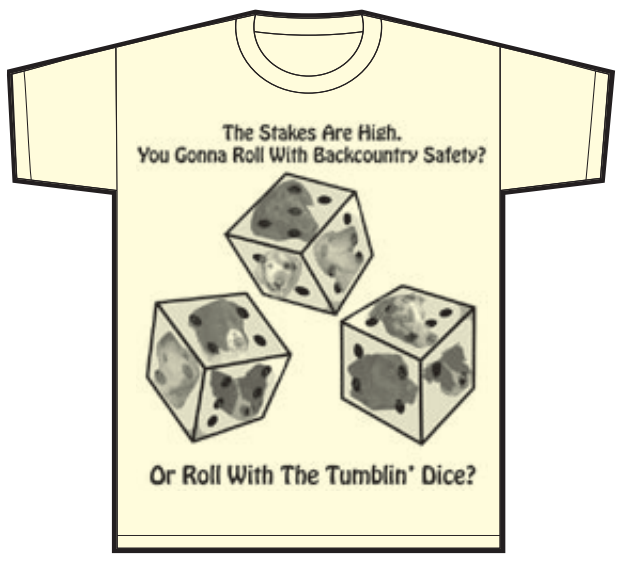
Last August, the two were called upon by Kittitas County, WA, Search and Rescue to locate a missing person in the Stampede Pass area. What would have taken considerable time utilizing traditional human searchers took Buzaka less than two hours: before nightfall she had located a 75-year-old missing woman who had lost her way in the huckleberry patches of the high Cascades.

This success story owes much to the countless hours of training that Kevin and Bazuka have logged as members of Alpental Backcountry Avalanche Rescue K-9, familiarly known as BARK.

Alpental BARK consists of eight handlers and 11 dogs, along with two support members based at Alpental ski area in Washington state. Additional BARK groups operate out of the Stevens Pass and Crystal Mountain ski areas.

Before the formation of a formal group at Alpental, there was one dog and handler: Katie Fitch and her dog Lucy started it all at Alpental in the 1990s. As others joined Katie, a local program came together. By 2004 a statewide program was creating, forming the collective group known as BARK. BARK now serves two purposes: it is a resource for training and certification, and it allows the group to be formally recognized by various agencies that perform search and rescue.

All of the BARK groups train and test their dogs to the same standards. In order to be certified by the group, a dog and handler must locate two victims buried 1-2m deep as well as two out of three buried articles in a 100x100m area. Victims and items must be recovered in less than 40 minutes. These testing standards are similar to those used in other parts of the US. Dogs and handlers must re-certify every three years, which makes for a challenging and evolving format.



BARK sells t-shirts, stickers and hats to fund the group's continuing training. *Artwork by Stimbuck*

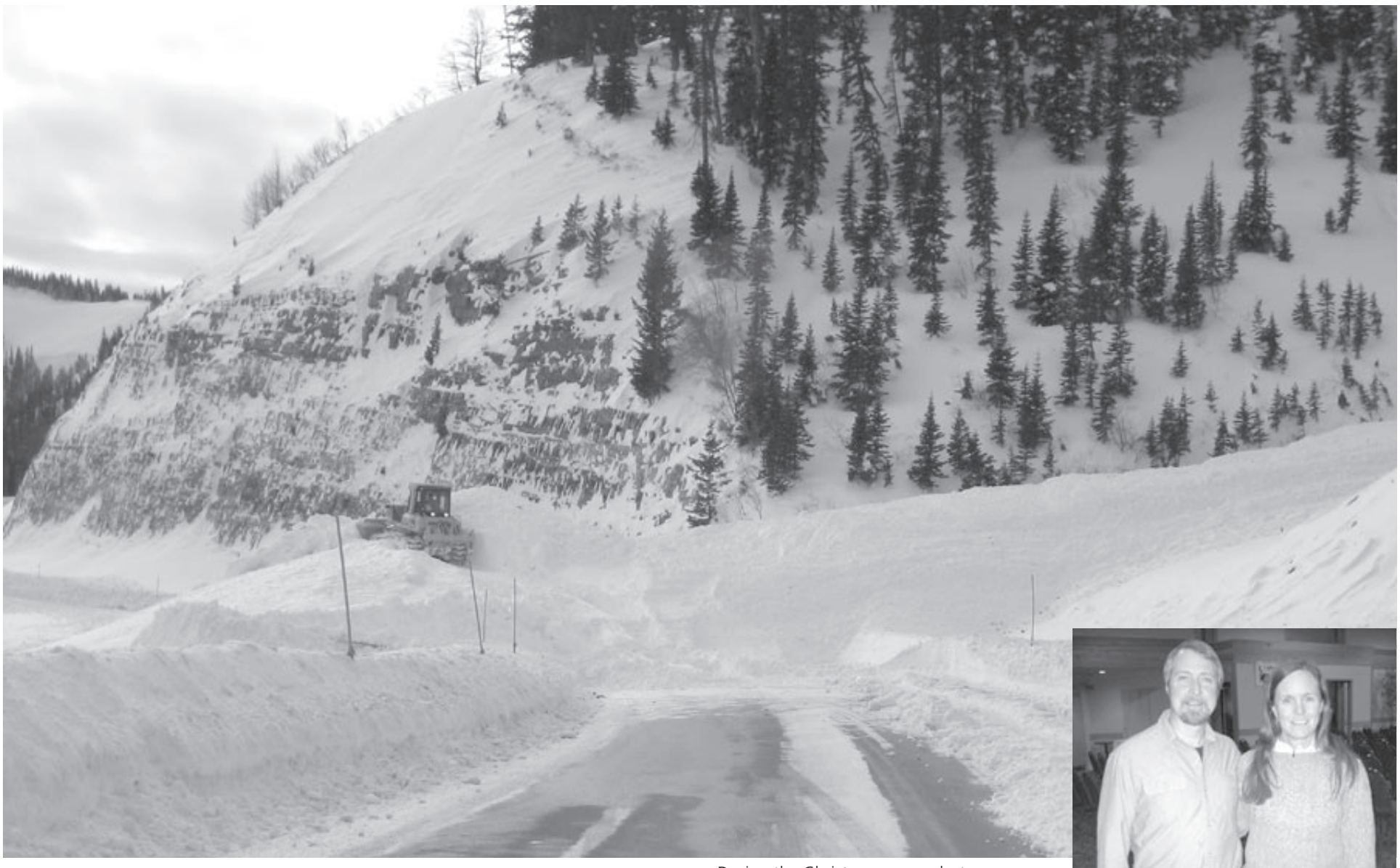
Reaching these standards requires alot of training. The local group meets every week to discuss training techniques and to practice as a group. The handlers and their dogs put in many more hours together, working on everything from obedience to mock rescues. As any dog handler knows, this means hours and hours of digging holes in the snow.

The Alpental BARK group, like others across the state and country, does more than just train dogs and perform search-and-rescue missions. In addition to being a mountain-rescue organization, the group is dedicated to reducing avalanche accidents through education. Members teach avalanche and mountain safety courses, and they perform public outreach about avalanche safety and the role their working dogs play in avalanche rescues. The group recently purchased and installed an Easy Searcher system at Alpental ski area, which the general public can use to practice beacon skills.

The group's public outreach serves another purpose: fundraising. As a nonprofit group comprised of volunteers, BARK requires funds to send dog and handler teams to Wasatch Backcountry Rescue classes, to AVPRO, or to the ISSW. In addition to merchandise, BARK holds an annual Backcountry Ball, featuring live music, food, an auction, and a costume contest.

This season's Backcountry Ball will be held March 6, 2010, at the Alpental Lodge on Snoqualmie Pass. Information about the event and about BARK can be found at www.avalanchebark.org.

Kevin Marston is a WSDOT avalanche forecaster, Alpental pro patroller, and owner of two labs: Hannah and Gretta. Kevin enjoys fly fishing, powder skiing, and the company of his family: his wife Meagan and two boys Gavin (5) and Owen (3).



During the Christmas season last year, one explosive release in Glory Bowl deposited over 50' of snow across Teton Pass road.
Photo by Jamie Yount

Jackson Avalanche Awareness Night

Story by Sue Miller

Early December in western Wyoming; questions arise: When's it going to dump? What's all this sugary snow on the ground? Should I take an avy course? All these are among the topics discussed at Jackson's annual Avalanche Awareness Night. Hosted by Snow King Resort and local retailer Skinny Skis, the event is supported by equipment manufacturers, shops, and educators alike – a dynamic collaboration of people supporting and presenting valuable information to winter enthusiasts of all forms and skill levels for well over 20 years.

This year's event was very well attended, with several hundred people buying raffle tickets and beer while acquainting themselves with the sponsors' booths. The mostly local crowd included beginner skiers and riders, Jackson Hole Mountain Resort rippers, snowmobilers, long-time backcountry aficionados, and professionals. Everyone was treated to an array of speakers willing to share their knowledge on various topics. The numerous presenters made for a long evening, but the many raffle prizes were a nice reward. The sponsors encourage other communities to start cooperative, informational programs like this one.

Rod Newcomb received a commemorative plaque to recognize the many years he has presented – with his signature overhead projector – the state of the snowpack on Teton Pass. This year Rod passed the torch to Don Sharaf, who shared his view of the current season snowpack – basically bony – with the aid of more modern technology: PowerPoint slides! Don predicted a variety of outcomes for our slow start with the snow this year, depending on subsequent moisture.

Jim Woodmencey, local meteorologist and long-time ski guide, consulted his oracles and gave us hope for a "phat" season despite the El Niño weather pattern in place for the winter. Our winters, as it turns out, are 50/50 in El Niño years – only half of these seasons have produced lower-than-average snowpacks.

Jamie Yount from WYDOT showed some spectacular photos of the slides that ran off Mount Glory and onto the Teton Pass highway last year. The Christmas '08 storm cycle was a very active avalanche period, with the largest slides in years. One explosive release in Glory Bowl on December 30 deposited over 50' of snow on the road *(see photo above)*. Other speakers included Mike Rheam of the Bridger-Teton National Forest Avalanche Center, keying us in to new features on the BNTF Avalanche Web site. One interactive feature uses Google Earth to pinpoint avalanche events reported by the ski area and the public. Teton Pass Ambassador Jay Pistono also introduced himself and reminded users of good manners utilizing the limited Teton Pass parking.

Event sponsors were very pleased to have Dr. Ian McCammon come and speak to the diverse crowd. Ian's keynote presentation, *Beyond the Void: Preventing Fatal Decisions in Avalanche Terrain*, was a further metamorphosis of his past research on heuristic traps and the flaws of decision-making. We keep repeating our mistakes and getting caught in avalanches, even the professionals. Ian pointed out how the strategies for making a decision in avalanche terrain – including analysis, heuristics, and intuition – all have problems in the face of rare, catastrophic events as avalanches. This leads us to face a "void," which Ian defines as the realization that our survival often depends on mere luck, even when we view ourselves as skilled. He acknowledged that it takes courage to face this void.

Ian suggested that there are three responses after facing the void: denial, spiritualism, and living by a code. He presented a code that is necessary for us to have as imperfect decision-makers. The code provides defined boundaries within which we can operate yet still retain freedom. Ian defined three parts to this code:

Don't die a stupid death.
One can use Ian's acronym ALP TRUTh to identify when an impending accident will look stupid.

Anticipate and agree on decision points BEFORE you get there.
Ian mentioned the airline industry's "sterile cockpit" idea to help group members discuss the right things at the right time.

Don't let your friends die a stupid death.
Here, Ian stressed the importance of carrying the proper rescue and survival equipment and knowing how to use it.

Ian balanced presenting the scientific research in this area with relating a personal story about the loss of a good friend in an avalanche years ago. He also referred to the many deaths of friends, acquaintances, and community members we have experienced in the Teton area, giving a rare emotional twist to the whole lecture. That personal connection may be just what it takes to get people's attention to not repeat the mistakes of our past, and move on to a new level of resourcefulness and responsibility.

Sue Miller is a long-time Teton guide and backcountry skier. She runs the avalanche education program for Jackson Hole Mountain Guides.

Keynote speaker Ian McCammon took a moment to talk with old friend and article author Sue Miller.

3rd Annual Northwest Snow and Avalanche Summit Held in Seattle

Story by Craig Wilbour

The third annual Northwest Snow and Avalanche Summit was held at the REI flagship store in Seattle on October 24, 2009. The Alpine Safety Awareness Program (ASAP) again did a masterful job organizing the event, which is similar to a day at the ISSW, but with a practical bent and without slide after slide full of formulas. This event was a benefit for ASAP.

The theme of this year's event was, *Risk Management in the Avalanche Industry.* Again a fine job was done of mixing local professionals with well-known speakers from outside the area. A lot of volunteer effort went into making the day a success. Of particular note was Sarah Stewart. Her organizational efforts and volunteer coordination provided participants and speakers alike with a highly professional event. Steve Christie of BCA again emceed, and his careful research and due diligence provided the audience with some particularly entertaining insights to each speaker.

Sponsors for the event included REI, BCA, Black Diamond, AIARE, American Avalanche Association, Cold Avenger, Outdoor Research, RECCO, Friends of the Avalanche Center, Feathered Friends, Ortovox, Vertical World, Cascade Powder Cats, Karhu, NWAC, Marmot, Brooks-Range Mountaineering, Cascade Designs / MSR, Rock & Ice, Trail Runner, Patagonia, Superfeet, Canaima Outdoors, Sterling Rope, POW Gloves, GSI Outdoors, Spy Optics, Sherpa Adventure Gear, La Sportiva, WSDOT, Native Eyewear, and Mountain Hardware. We thank all the sponsors for their commitment to avalanche education and safety.

In what has become an annual tradition, ASAP Executive Director Michael Jackson presented an award to a local professional who has proven a commitment to the avalanche community over many years. Since everyone else has retired, and I am the last man standing, I was given the NSAS "Biggest Flake" Award for my many years as WSDOT avalanche control supervisor and my mentorship over the years of the next generation of WSDOT avalanche workers.

Kenny Kramer of NWAC started the day with his presentation, *The Dangers in Interpreting the Danger Scale.* He talked about the semantics of risk and the scale of the risk. Colin Zacharias's topic heading was, *Snowpack Tests: Recent Research and a Guide's Practical Approach.* Simon Trautman discussed wet snow avalanches and their characteristics. Thomas Exner, a member of Bruce Jamieson's ADFAR team, talked about deep-slab instabilities, especially the snow structure that leads to deep-slab failures.

Expatriate Greg Johnson talked about the avalanche terrain exposure scale, developed in Canada, that is broken into three categories: simple, challenging, and complex. Ted Steiner presented the complexities of forecasting avalanche hazard and the politics of managing the hazard to the BNSF rail line as it crosses below a number of avalanche paths at the south end of Glacier National Park.

Mike Stanford discussed avalanche forecasting and control on the highways in Washington state with a focus on Stevens Pass. Rob Gibson talked about a project to make maps delineating where avalanche control is performed available to backcountry enthusiasts. The need for this safety information has existed for a long time, and now the GIS technology exists to make it a reality.

The day finished with a no-host beer garden with a Northwestern twist. Michael Jackson, a Bristol Bay commercial fisherman, had 200 pounds of his salmon smoked up for a taste treat to go with the beer.

I continue to see an excellent future for this type of one-day event. It is educational and fun.

Craig Wilbour is the WSDOT Avalanche Control Supervisor SCR.

Central Oregon Avalanche Association Fills Niche Between Hood and Shasta

The Central Oregon Avalanche Association (COAA) has been founded to enhance public awareness of backcountry avalanche hazards, promote winter snow safety, and provide snow condition and weather information to winter recreationalists throughout the Cascade Mountains of Central Oregon.

The grassroots organization, founded by Bend residents Trevor Miller and Jon Tapper, was established as a result of an identified need to promote increased avalanche awareness within the growing backcountry user base in the Central Oregon vicinity.

"With the spatial gap in coverage between Hood and Shasta, we wanted to begin coordinating local efforts and information exchange for all user groups – the skiers, snowboarders, snowmobilers, and wintertime hikers of the Central Cascades," said Miller.

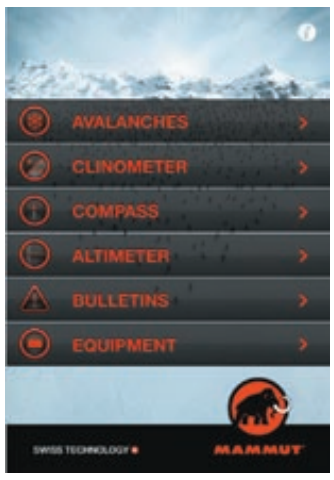
COAA has seen a dramatic rise in community interest after the unfortunate death of a snowmobiler on January 2, 2010, at Newberry Crater National Monument, outside of La Pine, OR. COAA is working with members of NWAC and the Oregon Avalanche Institute to develop the organization and are looking forward to working with other industry professionals.

"Helping create COAA will help create safer backcountry travelers. We just love snow, basically, "says Tapper.

For more information about COAA, go to www.coavalanche.org.

Mammut Snow-Safety iPhone App

Review by Greg Gagne



As the proud owner of a new iPhone 3GS which sports GPS capabilities as well as an accelerometer; I was curious whether my new toy, equipped with an avalanche-specific application, would be useful in gathering snow-safety information.Mammut Sports Group has released a free application for the iPhone and iPod Touch that backcountry skiers and riders – and perhaps snow professionals – may find helpful when navigating and assessing avalanche terrain. The most useful features of this app are an inclinometer, compass, and altimeter.

The inclinometer has an especially interesting feature that uses the camera in the iPhone to provide a view of the slope being measured as the background image of the inclinometer. I find there is potential for error when measuring slope angles via line of sight when using some standard inclinometers, as it is difficult to align the inclinometer with the slope being measured. By providing the slope as the background of the inclinometer, you align the inclinometer according to the image with less chance for error in your measurements. Furthermore, I conducted a few tests and verified the accuracy of the slope angles measured by the inclinometer.

The compass provides a simple, uncluttered interface.

I generally prefer barometric-based altimeters, as GPS-based altimeters can sometimes take 15-30 seconds to report the altitude, depending upon the number of satellites they are able to pick up. Plus, GPS-based altimeters are prone to relatively high error rates. From my experience, the altimeter reading in this app is accurate to within about 20 meters when being used in the open where it is able to receive multiple satellites. It is less accurate with varying degrees when used in trees.

For avalanche newbies, the app also provides links to basic avalanche education as well as the latest avalanche bulletins for locations worldwide. Of course these require either Wi-Fi or cell phone reception, so they are relatively useless in a backcountry situation.

My disappointments with this app are minimal: the app starts up with an annoying splash screen that takes seven seconds to load, and the links to avalanche education could be built into the app rather than links to Web sites. The links to avalanche bulletins are first organized by country, with 16 possible countries to choose from, followed by the specific bulletins for each country. If I'm on a ski trip to Canada, I don't really care about avalanche conditions in California, Colorado, or the Czech Republic. Simple GPS location could recognize that I'm in Canada and present bulletins for that country only.

Mammut should be congratulated for being the first to provide a snow-safety app, and the price is right. However, I am hopeful someone will rise to the challenge and take advantage of iPhone 3GS features to develop an app similar in nature to SnowPilot, so snow professionals could record complete pit profiles on the iPhone and submit them to a centralized database organized and accessed using GIS technology.

Overall I am pleased with this app as it packages three of the most useful measurements to the snow practitioner into a single tool. It will be a regular companion with me this winter.

Some caveats however: whereas all features of this app are available to iPhone 3GS users, the compass does not work for the iPhone 3G, and the compass and altimeter do not work for the iPod Touch.

The Mammut Safety App is available for free from the App Store using Apple's iTunes or visit www.mammut.ch/en/safetyapp.html for more details.

Greg Gagne is a professor of computer science at Westminster College in Salt Lake City and also works as a field observer for the Utah Avalanche Center (UAC) as well as instructor of avalanche classes offered by the Friends of the UAC. Got any ideas for the next killer iPhone snow-safety app? Contact him at ggagne@westminstercollege.edu.

Alaska Avalanche Specialists' new office in the blue building on the Juneau wharf at left gives new meaning to the phrase "sea level." Theirs may be the only avalanche office in the world that has tidewater coming and going beneath it. Owner Bill Glude reports that they are delighted to be in their new location, but notes, "You have to be super-careful not to drop your keys in the parking lot. They go through the cracks between the planks, land in the water, and are gone forever!" *Photo by Bill Glude*

The organizers of the ISSW 2009 are proud and relieved that their conference was a success

Three Years from Concept to Reality: ISSW Europe

Story by Roland Emetaz, AKA Mr Em • Photos by Bruce Tremper

The International Snow Science Workshop (ISSW), a North American institution, convened in Davos, Switzerland, for the first time September 27- October 2, 2009. "A Merging of Theory and Practice," the motto of ISSW, describes how scientists and practitioners sit side by side in participants' and presenters' shoes. Conducted with simultaneous translations in English, German, French, and Italian, 550 people from 26 nations exchanged concepts, information, and guidance.

Oral presentations and posters were too numerous to cover in this short paper, but I will try to highlight those presentations that are more likely to be of interest to snow recreationists.

The opening session, Avalanche Case Studies, was chaired by Rich Marriott, King 5, Seattle, Meteorologist and Friends of the Northwest Weather & Avalanche Center board member. It was a fitting opening for an international event with presenters from New Zealand, Quebec, Scotland, Italy and Switzerland. Summaries of several of the topics covered follow.

Author's note: The reader should bear in mind that the concepts, conclusions, and recommendations from papers are not necessarily specific guidance or recommendations from any particular body, agency, or organization.

Education/Avalanche Safety

Several education efforts were described in Posters Sessions, including *Safety is Freedom* (France) and *Avalanche Education as a Public Service* (Austria).

The former program was developed by a group of mountain and business professionals. Henry's Avalanche Talk (www.henrysavalanchetalk.com) aims to help backcountry skiers and boarders learn how to stay safe by providing quality talks, courses, and Web-based information products. They found that avalanche education needs to be promoted and marketed like any other effort to attract people. In the past year, 3000 people attended their presentations, and 20,000 have visited their Web site.

In 1999, in Innsbruck, Austria, Snowboard Pro and Mountain Guide Organizations conducted an avalanche camp/class at a local ski area. Snowboard Pro solicited and obtained sponsorship for the project, enabling them to offer the class at no charge. This was the start of a successful effort. Sponsorship from the outdoor industry and ski areas continues, and camps/classes are offered at no charge. In 2008/09, more than 40 camps were held at ski areas all over Austria. Since 1999, there have been over 10,000 participants. A more in-depth program, lasting three to five days, was started in 2003. In 2005, an avalanche-awareness program called SNOW-HOW was started in Innsbruck schools. This program targets 16-to-18-year olds and has an annual attendance of 800 students.

The take-home message from this presentation was to focus avalanche-awareness education on snow recreationists, the younger the better.

Reaching Unaware Users

Two-thirds of the people who died in avalanches in the United States were not wearing avalanche beacons. An estimated 90% of them did not consult an avalanche forecast. Likewise, forecasters are challenged to communicate that when mostly stable conditions exist, the general avalanche rating should not be applied to extreme terrain. In these areas slope-specific knowledge and significant avalanche assessment skills are a must!

The goal is to use a variety of methods to deliver the message, including showing pictures of previous avalanche sites and utilizing classes, radio, television, Web sites, billboards, trailhead signs, and mobile avalanche-information systems (cell phones). An avalanche education application in French and German for iPhones is expected to be available in Europe later this year.

It is hoped that through diversity in delivery, people will become aware of avalanche danger, take a class, carry the proper rescue gear and consult the avalanche forecast before heading out.

Develop a Strategy

- Identify the Target Users. Find out from them what works
- Design the Message. People are visual,so use photos, icons, and minimal text.
- Identify Delivery Systems. Confirm effectiveness of trailhead signs, internet, etc., with target audience.

Overview Of Methods For Risk Assessment And Decision-Making In Avalanche Terrain: "TO GO or NOT TO GO"

Risk assessment and decision-making tools for backcountry skiing, sledding, and riding have changed time and again, but basic knowledge about the factors contributing to avalanches has not.

In addition to the various warning programs and rating systems available in mountainous countries, there is an assortment of tools available, such as stability tests, the Canadian Avaluater, and the Swiss Munter's 3x3 Analysis. Some tools require considerable skill and experience to use them. Pattern recognition for the very experienced is important; following tracks is false security!

The bottom line opinions of some presenters and panelists are outlined below.

- If your intuition says "No," heed it. It is NO.
- If your intuition says "Yes," STOP and check conditions by rule-based systems such as stability tests, then decide whether to go or not. Better to do it then, than during the accident investigation! Also, GREEN (Low Danger) does not mean GO. Look to your left and right, then go.
- Key words among team members = Communicate, Communicate, Communicate. "And finally, if the only tool you have is a hammer, treat everything like a nail," Stephan Harvey, quoting Abraham Meslow.

Quick Stability Tests

Several posters and oral presentations concerned the Propagation Saw Test, Extended Column Test, Compression Test, and Rutschblock. *(See table below.)*

PST (Propagation Saw Test)	Cut a column of snow 30cm cross slope, 100cm up slope. Identify the weak layer, and drag saw through it. This test has the advantage of identifying weaknesses deep in the snowpack, while other tests are less effective.
ECT (Extended Column Test) CT (Compression Test) RB (Rutschblock)	Several studies seem to confirm that the ECT shows better results than the CT and is faster to prepare than the RB. The ECT may become the test of choice by at least some avalanche professionals. It is quick, easy, and can then be used frequently as one gains elevation or changes exposure.

Avalanche Survival Stategies for Different Parts of a Flowing Avalanche

Experience as well as research on avalanche dynamics has led to the following survival strategies for avalanche victims:

FIGHT LIKE HELL!

1. Once released, try to get off the moving slab.
2. After being caught, do everything possible to move toward the back or tail of the avalanche where you are more likely to be left behind.
3. In some cases, a backstroke and log-rolling motion may help keep you near the surface and more toward the flanks.
4. Avoid swimming with the flow, as doing so may lead you into the head of the avalanche, an area of turbulent flow where the odds increase for injury and deep burial.
5. Before coming to a stop, put one arm across face to help create an air space; push the other arm up.

Probing Strategies

Avalanche rescue beacons have significantly raised the survival chances in companion rescue in the backcountry, but in some areas – such as ski areas, highways, and some backcountry areas – users do not carry specialized equipment and may be unaware of its value. There continues to be a need to emphasize this equipment and to review probing strategies, alignment, and tactical considerations. Two probing procedures are outlined as follows:

1-HOLE-STEP

- limit probe line to 15 with one leader and one shoveler
- shoulder-to-shoulder spacing
- probe vertically between feet
- point probe ahead 50cm (20") to mark next probe point
- probe vertically 2m (6' 6")
- HIT: leave probe in place & call for shoveler
- prober gets new probe and continues probing

3-HOLE-STEP

Various versions of the 3-hole-step have been studied and implemented: one where the probes are inserted vertically, the other where the outer probes are placed at an angle. The 3-hole-step is preferred when only a few rescuers are available. The 1-hole-step is preferred when many probers are available.

Multiple-Victim Beacon Searcher

Various poster presentations were displayed, primarily from beacon manufacturers. Backcountry Access suggests more training for searching in parallel, which can be applied in both single and multiple burials. In single burials, the searchers spread out according to a standard search-strip width of at least 20 meters. In multiple burials, this search-strip width can be adjusted according to the size of the deposition area and the number of rescuers. Searchers are instructed not to deviate from their search strip until a specific distance is shown on their beacon. This distance corresponds to the search-strip width being used by the group. This ensures that no rescuer complicates the search by crossing other search strips. Go to www.bankcountryaccess.com/research for a more detailed explanation.

Making Hard Decisions in Avalanche Rescue: RISK Versus BENEFIT

Risk to avalanche-rescue personnel in avalanche terrain can be compared to settings where structures may collapse, or hazardous materials are present. It is important to maintain a decision process that is high quality, transparent, and defendable in hindsight. Bottom line: have a structured approach, consider probabilities of outcome, and limit exposures of rescuers.

Update Hypothermia and Medical On-site Triage of Avalance Victims

An avalanche victim is a medical emergency! Survival chances depend on the existence of an air pocket and the time of burial. Avoid destruction of air pockets during extraction. Avoid unnecessary movements of trunk and main joints (shoulder, hip, knee). If movements cannot be avoided, carry them out as slowly as possible. Severe hypothermic victims without signs of any life have been resuscitated. No hypothermic avalanche victim with free airways should be considered deceased – always attempt to resuscitate.

One of the great benefits of any ISSW is the informal information exchange over a beverage after a presentations session.

International Commission For Alpine Rescue (IKAR)

IKAR is divided into four commissions: Ground Rescue, Air Rescue, Avalanche, and Medical. For more information, see www.mra.org/training/ikar.php and www.ikar-cisa.org.

IKAR's history in mountain rescue operations and standards goes back to 1948. The group includes 60 members from 30 nations. Neither Russia nor China are represented yet. The goals of the organization are three-fold: to exchange information, to review accidents, and to develop standards and guidelines.

Avalanche Triggering by Sound: Myth or Truth

Even though disproven in the past, it remains a popular myth that avalanches can be triggered by sound. This study compared the impact of sound from supersonic booms caused by low-flying military aircraft and explosives on the snow cover. The study showed that amplitudes are at least about two orders of magnitude smaller than known efficient triggers. Therefore, shouting, motors, or other loud sounds can be ruled out as triggers of snow avalanches.

Estimating the Economic Value of the Avalanche Forecast

European avalanche forecasters provide forecasts in several ways, including through Web sites, newspapers, TV, and text messaging. The users of the forecasts are charged only a nominal fee to covers transmission costs (e.g., phone or internet provider), but bears no relationship to the cost of creating the product.

A survey of 1600 users determined that they were willing to pay for improved forecasts (roughly equivalent to $50-80 USD annually). On the other hand, professional mountain guides, experienced backcountry skiers, risk-tolerant persons, and skiers who perceive their risk as below average were significantly more likely to refuse to pay for improved forecasts.

Impact of Climate Change on Ski Season Length

A number or oral presentations focused on climate change and its impact on the ski industry in Europe. The studies indicated that even today, natural snow cover is not reliable any more. There were at least 100 days with snow depth 30cm (1') from 12/1/08 - 4/15/09 at the lowest elevations 1200m (3,960') of some resorts. By 2050, natural snow reliability will be questionable even at intermediate elevations 1500m (4950'), at least in Switzerland and Austria.

Future ISSWs

- Lake Tahoe, CA .....October 17-22, 2010
- Anchorage, AK 2012
- Europe (FR).....2013
- Canada.....2014

Mountain Service of the Czech Republic

After ISSW, I traveled to eastern Europe to a rather remote location in the Czech Republic to visit with Mountain Service where I worked 15 years ago.

The Mountain Service of the Czech Republic provides ski patrol to ski areas and dispersed areas, as well as mountain rescue and emergency medical services to the mountainous and rural areas of the country. The Mountain Service has 89 full-time and 50 part-time paid employees, as well as 500 volunteers.

A two-year-old national law requires that outdoor safety education be taught in schools, primarily in the rural mountainous communities. Mountain Service teaches the teachers (through annual eight-hour seminars) rather than the students, which is a more efficient use of Mountain Service time. Schools donate funds to Mountain Service. In turn, Mountain Service assists schools with mountain-oriented sports events such as ski races, bicycle races, etc.

I worked with Mountain Service for two months, 15 years ago. This recent visit was a social one, although we spent some time discussing various topics of mutual interest, such as the Incident Command System (ICS and ICE – *ICE on a cell phone = In Case of Emergency, call…*). As a result of our discussions, ICE may be incorporated nationwide in the future.

Roland V. Emetaz, aka "Mr Em," is a retired forester with the USDA Forest Service, Pacific Northwest region. After devoting his long, enjoyable career advocating outdoor safety, quality customer service, and teamwork, Mr Em continues as a volunteer teaching those lessons. He represents the Northwest Weather and Avalanche Center during avalanche-awareness programs. At other times he is on assignment with the Central Washington All Hazards Incident Management Team (one of 54 in the nation) managing incidents as diverse as wildfires and hurricanes from the Artic Circle to the Gulf Coast. Office: Starbucks-I205/Mill Plain Blvd-Vancouver, WA, emetaz@earthlink.net.

Vicuna, Chile, 11/7/09

Mark Rawsthorne, assistant avalanche forecaster in Portillo, Chile, gives Reggie the avalanche dog his summer "beach cut" at a local beauty parlor after a long arduous winter. They were visiting Vallie de Elque, the noted Pisco grape-growing area in the southern Atacama region. Lisa Issenberg was the styling assistant.

Report & photo by Jerry Roberts, reporter at large

Snowpro Plus+ Tool Tips

Story by Gary Sims

Snowpro Plus+ has been used in the snow industry by ski hills, heli-ski operations, backcountry guides, highways ministries, researchers, recreational users, and other snow professionals for over 15 years. During that time we have made many improvements and added many new features.

This year we have added new shear tests and combined our software license and annual support option into a simplified subscription license that allows you to be always current with the latest features through the automatic update.

The CSAC definition of a snow profile is "a cross-section view of snow stratigraphy and associated physical parameters usually obtained from a snowpit." This is what Snowpro Plus+ is best at – producing snow-profile graphs. Additionally, Snowpro has a number of features you might not know about that may be useful in your snow operation.

Author's note: The information in this article presents the features only. See the Snowpro Plus+ User Manual or Integrated Help for detailed instructions on setup and use. The illustrations here are not representative of real profiles and are for demonstration purposes only.

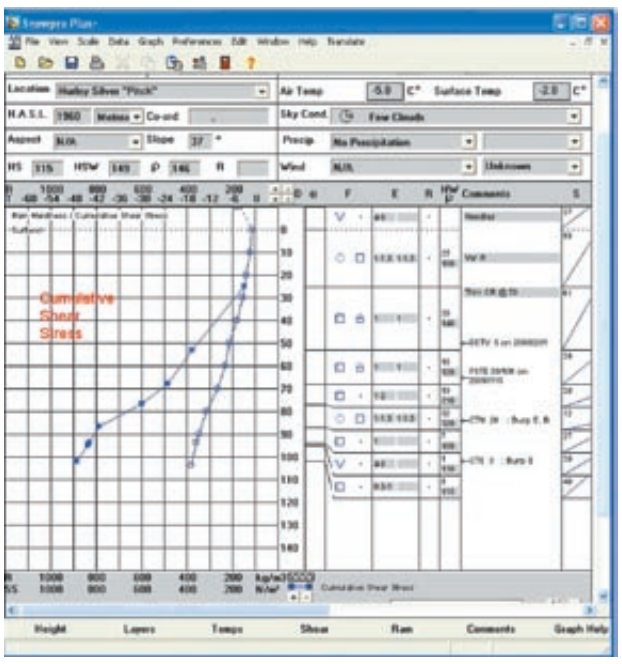


Figure 1

Cumulative Shear Stress or Cumulative Snow Load Plot Lines

Snowpro is capable of drawing a graph line showing either the cumulative shear stress or cumulative snow load. Figure 1 shows a sample of a shear stress plot line (left) with a snow temperature plot line (right). The calculations use the layer thickness, either the profile slope or individual layer slope and the density of each layer to derive the stress or load values. The SS or SL scale along the bottom of the graph shows the values; these are adjustable for units or scale range. The calculated values can be viewed by moving the cursor over the small squares on the plot line.

Snowpro has two slope options. The traditional calculation uses the profile slope (37% in this example). We have also included an experimental option to use the individual layer slope values. This is shown on the right side of Figure 1 but is not included in the calculations here. *(See User Manual or Integrated Help RE: enabling layer slopes.)*

Figure 2

It is unknown whether individual layer slope values give better values than the profile slope. Perhaps someone in the snow community would like to do further testing to determine this?

To enable the cumulative plot line open up the Preferences General Tab *(See Figure 2)* and select the "Shear Stress Show On Graph" check box. Select the Plot Type, Units, and Use Slope values.

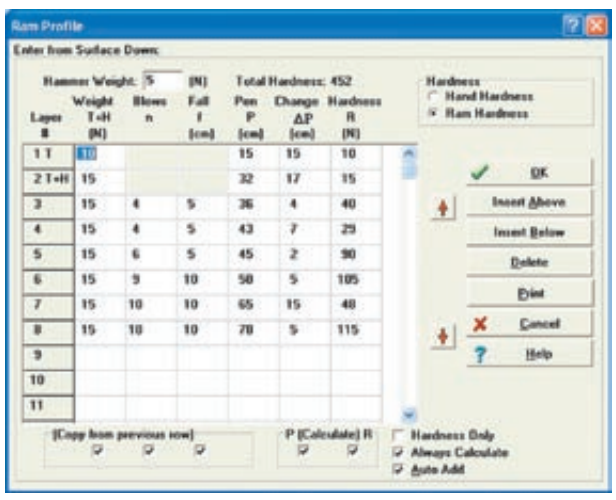


Figure 3

Ram Profiles

Most people doing snowpit hardness tests use the Hand Hardness test since it's quick and easy. However, Snowpro Plus+ has a table that captures ram information from a Ram Profile (Ramsonde). The ram test is performed by driving a ram penetrometer into the snowpack by dropping a "hammer" weight onto the rod or tube. A series of measurements are obtained. These can be directly added to the Snowpro Ram table, and the ram hardness is automatically calculated and shown on the graph.

Figure 3 *(above)* shows the Ram table filled in. Enter the hammer weight and the combined hammer and rod weight in column 1, the number of blows in column 2, the fall height of the hammer in column 3, and the total penetration of the rod in column 4. The software calculates the change in penetration in column 5 and the hardness for each row in column 6 as well as the total hardness. Once the table is saved, the ram hardness is shown on the profile graph.

Flags/Lemons

In 2005 Bruce Jamieson and Jürg Schweizer, in their paper, *Using A Checklist To Assess Manual Snow Profiles,* identified three layer properties and three interface properties that would be tested against critical ranges and would be used to flag instabilities in the snow profile. This has been implemented in Snowpro Plus+. Details and references can be found at www.snowproplus.com/flags.htm.

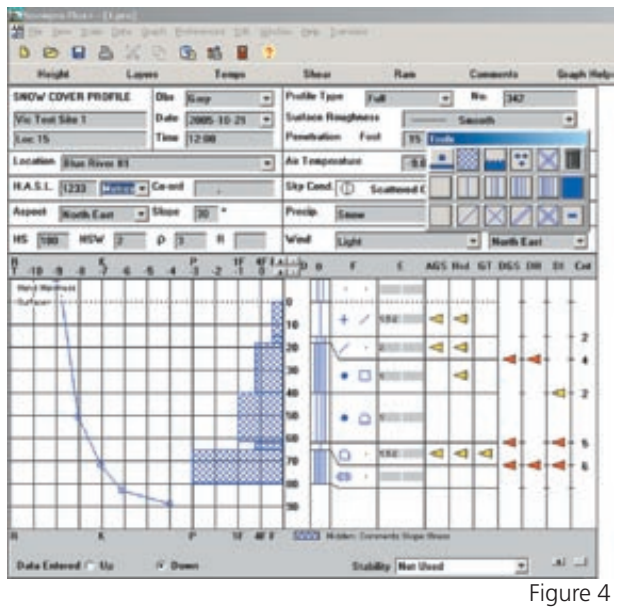


Figure 4

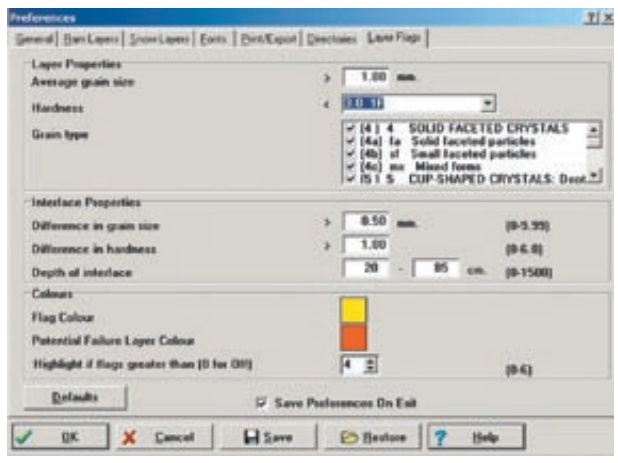


Figure 5

Figure 4 shows a sample of a profile showing the flags with three interfaces highlighted in red indicating possible instabilities. The interface criteria can be user configured as shown in the Preferences/Layer Flags dialog in Figure 5. This tool makes it very easy for novices to recognize the unstable layers. However, as noted by Jamieson and Schweizer, "Its value in making decisions about avalanche risk is unclear, especially for experienced avalanche practitioners."

Free Trial and Special Offers

To try out these features, a free full-featured Snowpro Plus+ 15-day trial can be downloaded at www.snowproplus.com/demorequest.htm.

A special "2-for-1" Snowpro Plus+ new and renewal subscription licenses are offered for TAR readers during February 2010. Additionally, the annual subscription period on these will be extended to September 30, 2011. See www.snowproplus.com during February, and use code TARP01 when ordering.

References

Jamieson, B. and J. Schweizer. 2005. Using a checklist to assess manual snow profiles. *Avalanche News* 72, Canadian Avalanche Association, Revelstoke, BC., 72-61.
www.eng.ucalgary.ca/Civil/Avalanche/Papers/ChecklistProfiles.pdf
www.snowproplus.com/tips.htm#tt0901

Gary Sims is president of Gasman Industries Ltd. in Victoria, BC. He has been involved in the snow industry since 1985 as a software programmer and developer of Snowpro Plus+ software. He continues to promote software tools to aid in avalanche prevention. Please contact him at info@gasman.com with topic ideas for future Tool Tips.

AIARE Offers Introduction to Avalanche Safety Course Materials for Educators

AIARE is providing course materials for educators to present an Introduction to Avalanche Safety course. The Introduction to Avalanche Safety course is an intermediary step between basic avalanche awareness and the Level 1 course as defined by the American Avalanche Association's *US Avalanche Education Progression*. Lesson plans within the document present the mainly field based course over a one-day time frame.

The introductory course is intended to target riders frequenting avalanche terrain via lift access from ski areas and easily accessible backcountry trailheads and highway passes. This terrain – also known as "near county" or "slack country" – sees high local use, typically from young and relatively inexperienced users whose travel is limited to day trips.

Course materials include a course overview and instructor lesson plans, 20 NAC *Avalanche Safety* brochures, and a *Stay Alive* DVD.

AIARE received assistance developing these materials from The Hans Saari Memorial Fund, Friends of the Gallatin National Forest Avalanche Center, and The National Avalanche Center.

A $10 fee covers shipping and DVD reproduction. To order course materials, see www.avtraining.org and go to "Store" in the top menu bar.

Dynafit Introduces New Skis & Boots

Dynafit says their new Titan TF-X boots "know no limits," combining power and shaving weight for all your mountaineering and freeride touring needs. This award-winning boot is the stiffest and most powerful boot for the descent with no compromises on the ascent. With its triple binding soles, trademark quick step-in insert, and alpine overlap construction, Dynafit claims the Titan TF-X will make every professional feel like a Greek Sun God driving a chariot across the heavens.

The Manaslu ski (122-95-108) is Dynafit's "Lord of the Summit." The combination of a 23cm long shovel, renegade iso-paulownia wood core, and tight dual-radius cut (35/21 cm) makes this ski ideal for snow professionals and mountaineers alike. Weighing in at only 6.2 lbs per pair, the Manaslu finely balances weight, performance, and flexibility.

For more information, see www.dynafit.com.

snow science

Burn, Baby, Burn

Story by John Brennan

Necessity, they say, is the mother of invention. Certainly that sentiment held true during the early stages of explosive engineering. While seaside forts were concerned over static predetonation of their black-powder caches in the 14th century, the mining industry in the 1800s was plagued by accidents surrounding the ignition methods for their black-powder blasts.

William Bickford had no immediate connection with the mining industry. His financial well-being was attributed to his career as a currier and leather merchant. Nonetheless, he was keenly aware of the accidents occurring in the tin mines in England during the early 1800s, and he set out to find a solution.

During this period, black-powder shots were ignited by crudely fashioned fuses made of black-powder-filled goose quills or paper straws. After some initial failures, Bickford found providence when he saw a rope-making machine in action around 1830. He soon fashioned a machine that wound jute, a plant fiber, around a core of gunpowder. Completing the process, a varnished outer sheath was added to waterproof the assembly.

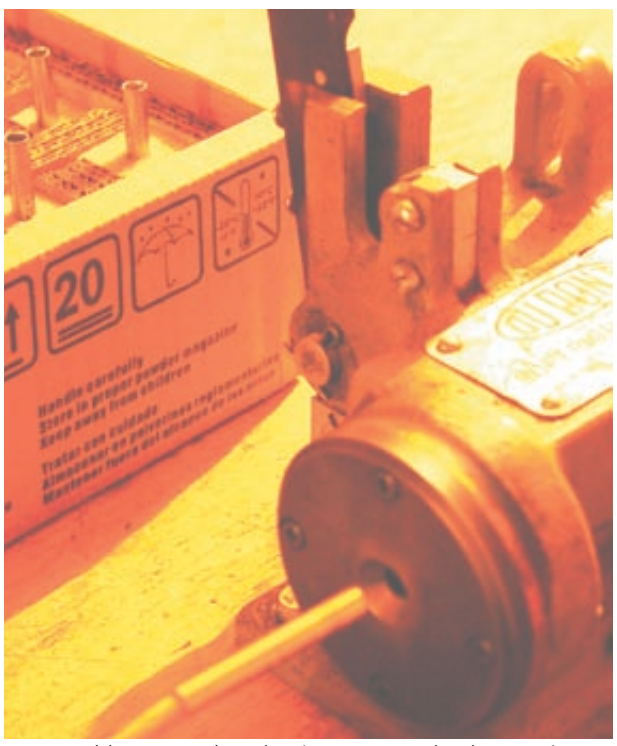
In an unfortunate twist of fate, Bickford perished in 1834 just prior to the opening of his first safety-fuse factory. It would have made the ingenious Bickford proud to know that in his Tuckingmill factory's first year, almost 45 miles of his invention was produced.

Several years after opening the first commercial safety-fuse factory in the world, the corporation took their business overseas to the United States. It was at this point that the company became Ensign-Bickford, with its headquarters relocated to Connecticut.

As an avalanche and explosive specialist, I have heard many times that safety fuse is an old and antiquated technology. While the former is certainly true, I adamantly disagree with the latter. From its humble beginnings, safety fuse saw immense growth over the decades since its invention. The simplicity of use, cost effectiveness, and reliability are several of the factors that can be attributed to its continued success.

Fuse winding machines in action. *Photo courtesy of WANO Schwarzpulver GmbH*

Part of the fuse-fabrication process in India.
Photo courtesy of Commercial Explosives (India) Ltd



A venerable DuPont bench crimper at work. These units are no longer manufactured. *Photo by John Brennan*

Reliability of safety fuse cannot be understated. In his excellent article, *In Defense of Safety Fuse*, in the International Society of Explosive Engineering's journal, Fred Hynes states, "As a field employee of the DuPont company and, later, the Ensign-Bickford company, I investigated many safety-fuse accidents, mostly fatalities, and never once was there any evidence of fast-burning fuse, although fast-burning fuse was always the claim of the survivors. I realize that what I am going to say hereafter flies in the face of old, treasured mining folklore, but it needs to be said in order to convince the younger generations of miners, most of whom have never seen safety fuse, that safety fuse is just that, it is safe; it never burns faster or slower than it is designed to burn. However, safety fuse is only as safe as the man who is using it, and that is where the problem lies."

One of the world's largest producers and users of safety fuse in recent years has been Africa. In an ironic twist that would see Bickford grinning proudly from the grave, a used Tuckingmill fuse-fabrication machine was sold to the African explosive behemoth African Explosives Limited (AEL) in the early 1960s. AEL not only began production of safety fuse, but they also manufactured their own black powder for their product. This seems to be a typical trait of fuse manufacturers; Wano, a fuse manufacturer from Germany, has been making black powder since 1682.

During AEL's fuse plant's heyday in the mid-1980s, over 1.4-million meters of fuse were spun each day! At this point, it took 182 fuse manufacturing machines to meet the market demands. While production has slowed at AEL to only about 700,000 meters per day, it can be clearly seen that safety fuse is in no imminent danger of extinction in Africa.

Indeed, aside from the geocentric philosophy of most US explosive users, safety-fuse manufacturing is still alive and well in many other countries around the world. India is a major manufacturer, with numerous producers of black powder and safety fuse. Annual countrywide production numbers are in the hundreds of millions of meters. Peru deserves mention at 60-million meters a year. And, while Germany manufactures a quality fuse, their production numbers are only in the 1000-kilometer-a-year range.

Bulk fuse is currently imported into North America through Petro-Explo, Inc., in Arlington, Texas. Their staple fuse products from Tec Harseim in Chile were recently cut as that factory, most recently owned by Dyno Nobel International, shut their doors in 2003. Petro-Explo now imports similar products from Mexico.

The majority of USA bulk fuse users are now using the Dyno USA-owned Compañia Mexicana de Mechas Para Minas fuse sold under the trade name Cobra Fuse. Previously, Tec Harseim produced a military spec fuse that found favor with avalanche-control programs that liked its hotter spit and burning characteristics. While Compañia Mexicana produces a similar product, contractual agreements with Ensign-Bickford Aerospace make it unavailable for commercial use until at least 2012.

Despite the staggering amounts of safety fuse still being produced worldwide, users should resist being lulled into a false sense of product availability. Shock tube initiating systems are drastically cutting into the safety-fuse market. Several countries, such as Russia and the United States, have prohibited the use of safety fuse in some mining applications.

AEL, the largest manufacturer of safety fuse in the world, has invested heavily in the manufacturing of shock tube: a thin plastic tube lined with a dusting of high explosive. When initiated, the detonation signal is passed through the tubing at 6500 feet per second without rupturing it. The tubing is an inexpensive, highly reliable, and safe way to initiate a blast. Unfortunately, it is a system that doesn't lend itself readily to avalanche control. The need to couple the blaster to the explosive charge is an obvious challenge, as is the need to collect the spent tubing.

An interesting characteristic of the core of some safety fuse is its ability to carry a static charge – a phenomenon that Canadian authorities feel could cause predetonation. Because of this concern Canada, and only Canada, mandates the use of pre-manufactured blasting-cap/safety-fuse assemblies that have a shunting staple installed. This staple provides a preferential pathway for the static charge to ground itself through. It is important to note that blowing snow can generate in excess of 20,000 volts of static electricity.

There is quite a bit of commercial interest in the cap and fuse market that exists in North America and around the globe. A better-educated consumer can ask their explosive distributors about the availability and cost of other international product alternatives. It is Avalanche Mitigation Service's aim to be apprised of the safety-fuse options available. Contact us with your comments and concerns at jb@avalanchemitigationservices.com

Related Reading

Increasing Explosive Safety, John Brennan, 2002, www.avalanchemitigationservices.com/articles.htm

In Defense of Safety Fuse, Fred Hynes, ISEE, March/April 1985. Contact John Brennan for copies.

John Brennan has been a member of the National Ski Area Association's Explosive Committee since 2002 and on the Avalanche Artillery Users of North America Committee since 2004. He is pleased to note that he recently sold his 10th Falcon GT Avalauncher.

Photo Centerfold

Recent R3D3-size soft-slab avalanche naturally triggered from wind-loaded storm snow. Secret Valley Chutes, Coast Mountains near Juneau, Alaska. *Photo by Bill Glude*

This is the scene AAA member and avalanche forecaster Ron Perla sees daily of the Rundle Range above Canmore, Alberta. On one of his Rundle Range solo climbs not long ago, he was inching his way up technical rock carrying two cans of bear spray. Through the woods came the sound of a large bear too close for comfort. Quickly Ron grabbed one can of bear spray while hanging onto rock. As the bear closed in for a better look at this avalanche pioneer, Ron slipped, sprayed himself in the face, let go a might roar, and the bear, smarter than most grizzlies, U-turned back into the woods, leaving the wild man hanging by a thread. Don't let this happen to you!

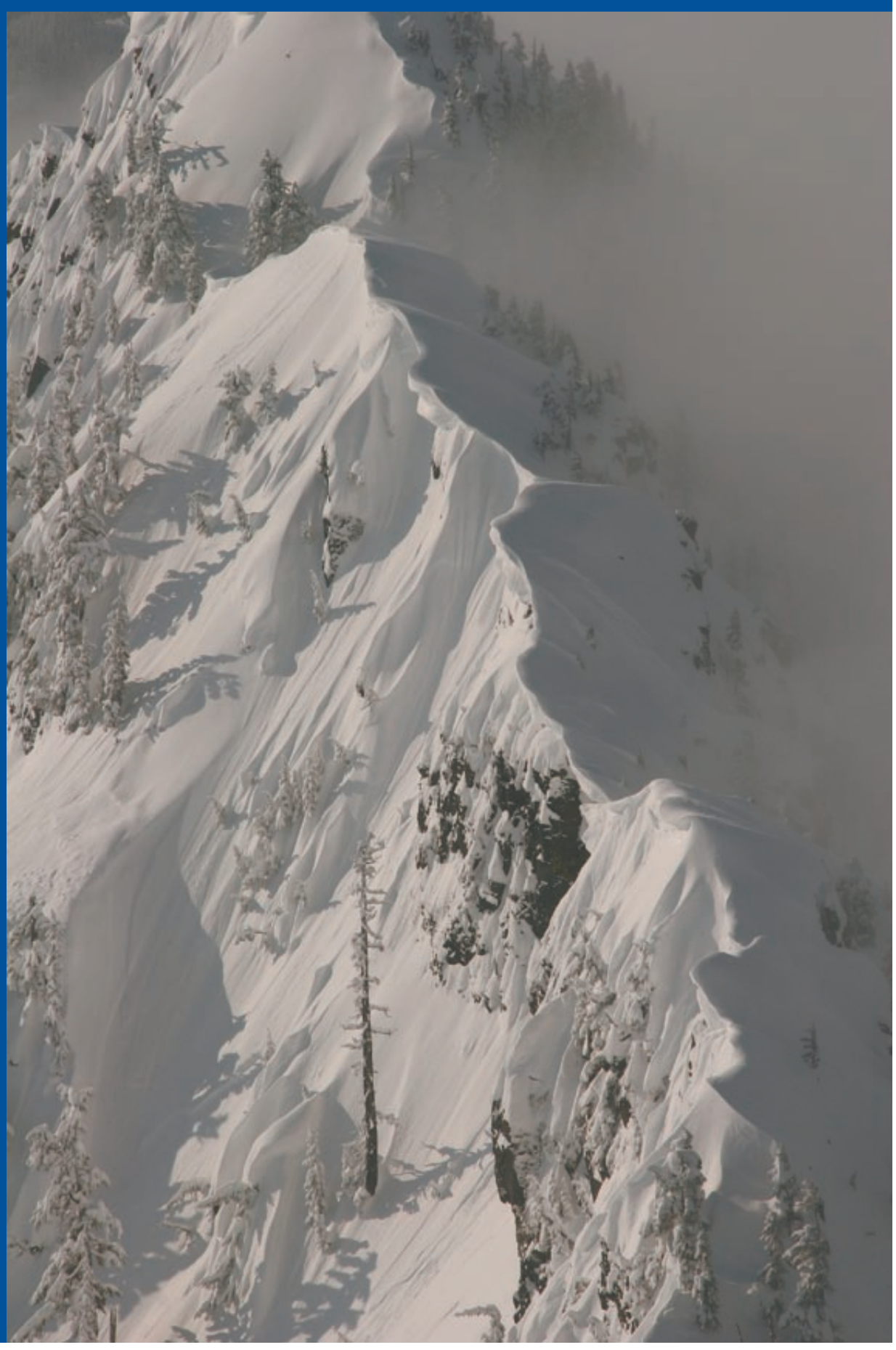
Photo by Ron Perla, story from Rod Perla via Art Judson

This large avalanche on Cornice Ridge, Logan, Utah, must have occurred on Christmas Eve or Day. Judging by the proximity of the tracks on the ridge, it looks like it was triggered remotely by someone riding along the low-angle ridge. HS-AM?-d3-r5-O doesn't quite capture it, as it looks like most of the cirque avalanched in one big event. My partner Josh dropped into the bed surface on the southern part of the avalanche, near debris piled deeply on trees and into an abrupt sinkhole below the slope.

Photo by Toby Weed, UAC Logan forecaster

This is what happened to Perfect Valley on Black Friday: March 21, 2009. The world came down in three mountain ranges up here. Nasty. My first serious accident too. (Wizard Gullies) Thank goodness they weren't in Perfect! You can see where the snow crawled up and over the big whaleback in the center of the valley. This was a bad day in the backcountry, and it affected more folks than Sorcerer. You can find current snow/avalanche conditions at Sorcerer and other BC backcountry lodges at www.wisegoat.ca.

Photo by Tannis Dakin, Sorcerer Lodge, BC



Seen from the summit of Denny Mountain, this ridgeline looms above Edelweiss Bowl at Alpental ski area in Washington. The photo was taken while on an avalanche control route called "Over the Top."

Photo by John Stimberis

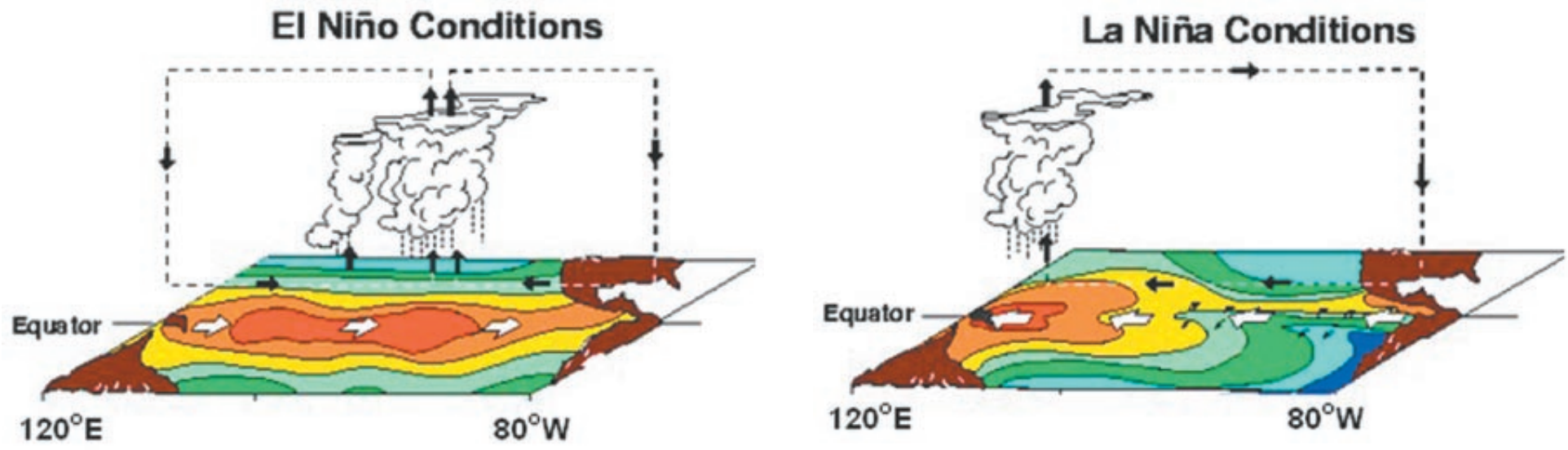


Fig. 1: Typical atmospheric circulation patterns and ocean surface temperature anomalies during ENSO-positive (El Niño) and ENSO-negative (La Niña) events.
Illustrations courtesy NOAA Pacific Marine Environmental Laboratory

Seasonal Weather Predictability: A Look at ENSO and MJO

Story by John Snook

Is it going to snow this winter? Will we have a good snow year? Every fall, these are questions that meteorologists get asked by outdoor winter recreationists. Seasonal climate records indeed show that there are regions of above-average snowfall and areas of below-average snowfall each winter season. But is there any chance of predicting ahead of time who those winners and losers will be?

Many consider the invention of the barometer in 1643 by Torricelli to be the beginning of meteorology as a science *(Haltiner and Williams, 1980)*. But it wasn't until the 19th century and the invention of the telegraph that scientists recognized the importance of collecting meteorological observations from around the globe to construct weather maps used in weather forecasting. The invention of the weather balloon in the 1930s provided the first regular look at the upper atmosphere. Oceans cover about 70% of the planetary surface. The lack of atmospheric observations over oceans has long hindered the ability to understand global weather patterns and to better predict future weather. The first weather satellite was launched in 1959, and satellites have since provided a new view of the global atmosphere.

Weather predictability accuracy has greatly increased during the past several decades through enhanced atmospheric observational systems, faster computers, and computer forecast models. But these improvements are primarily confined to weather forecasts of a week to 10 days duration at best. Ensemble computer forecasts, which use stochastic approaches to initializing the model, have shown success at extending the forecasting window out to two weeks.

Stochastic (from the Greek στοχος for aim or guess) means random. A stochastic process is one whose behavior is non-deterministic, in that a system's subsequent state is determined both by the process's predictable actions and by a random element. However, according to M. Kac and E. Nelson, any kind of time development (be it deterministic or essentially probabilistic) which is analyzable in terms of probability deserves the name of stochastic process.

source: Wikipedia

Edward Lorenz' *(1969)* studies of chaos theory have described the theoretical limits of computer forecast model predictability. He showed that small differences in the model initial condition can result in large differences in the resulting weather prediction for a week later. Hence, it is difficult to numerically predict weather beyond a certain time frame, since it is impossible to exactly define the initial state of the atmosphere. The so-called "butterfly effect" rationalizes that a butterfly's wings could create tiny atmospheric changes ultimately altering the path of a tornado So the question remains, is weather predictable beyond two weeks?

The butterfly effect is a metaphor that encapsulates the concept of sensitive dependence on initial conditions in chaos theory; namely that small differences in the initial condition of a dynamical system may produce large variations in the long term behavior of the system. Although this may appear to be an esoteric and unusual behavior, it is exhibited by very simple systems: for example, a ball placed at the crest of a hill might roll into any of several valleys depending on slight differences in initial position.

source: Wikipedia

Long-term climate records show the existence of atmospheric oscillations that affect weather patterns with a large range of time scales ranging from monthly, to seasonal, and even decadal. Local fishermen along the Peruvian coast have recognized for over a century that seasonal changes in ocean temperatures affect year-to-year anchovy fish harvests. Typically, a cold ocean current moving from south to north keeps low latitude Southern Hemispheric waters cool enough to support abundant anchovy fish. In some years, however, sailors observed a north-to-south moving "counter-current" that abnormally warmed

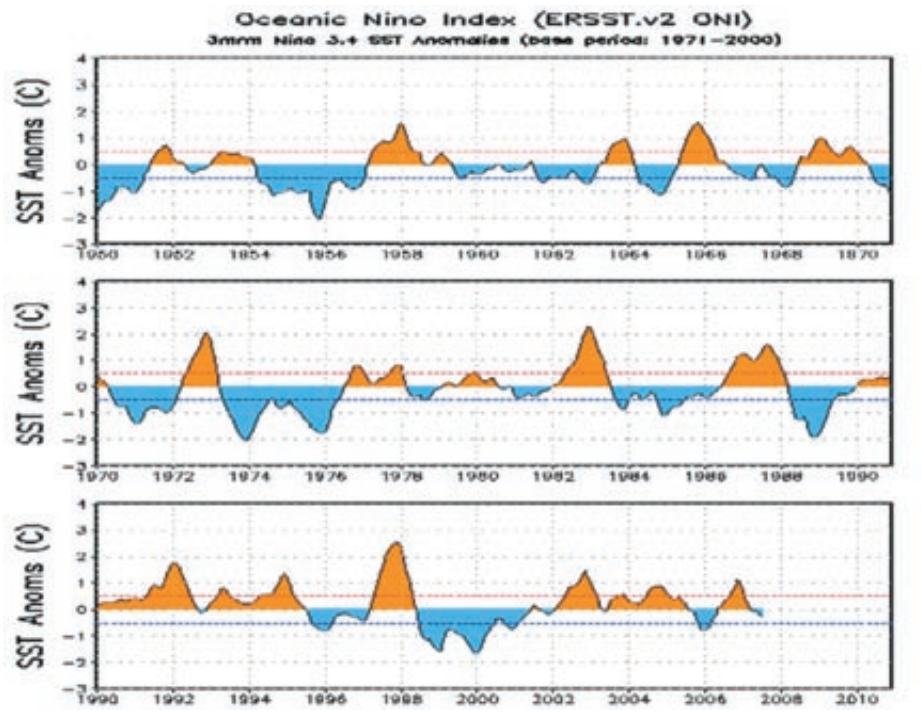


Fig. 2: Eastern equatorial Pacific sea-surface temperature anomalies for the period from 1950 through 2007. Positive anomalies (orange) indicate El Niño events while negative anomalies (blue) represent La Niña events. *Data courtesy NOAA Climate Prediction Center*

Peruvian coastal water temperatures. This counter-current was named the "current of El Niño" (Spanish for "the Christ child") because it often appeared immediately after Christmas *(Philander, 1990)*. The warm current severely reduced the anchovy catch, but provided heavy rains in a part of the world that is normally a desert.

Weather satellites are well-known for providing views of cloud patterns, which allow improved lead time to identify approaching storms. In addition, satellites are capable of sensing sea-surface temperature (SST). With three decades of SST observations available, scientists now recognize the importance of changing SSTs and their synergistic relationships with atmospheric oscillations. Researchers have since recognized that these seasonal changes along the Peruvian coast are correlated with seasonal shifts in atmospheric weather patterns. The changes are now known as the El Niño-Southern Oscillation (ENSO) and its regional influence goes well beyond the Peruvian waters. Other atmospheric oscillations have been discovered including the Madden-Julian Oscillation (MJO), the North Atlantic Oscillation (NAO), the Pacific North American Pattern (PNA), the Pacific Decadal Oscillation (PDO), the Northern Pacific Pattern, and the Eastern Pacific Pattern.

Winter storm track and intensity will determine whether it will be a warm or cold season and whether it will be wet or dry. Long-range weather forecasters now look to the state of the oceans for clues to storm track and intensity. Both ENSO and MJO circulations have a predictable influence on the jet stream, which shapes the storm track.

This article focuses on these two atmospheric oscillations – ENSO and MJO. El Niño discussions are frequently picked up by media and marketing agencies. They boast of bountiful snowfall resulting from El Niño "weather." The result can be misunderstandings and false expectations. A description of these two atmospheric oscillations and understanding the benefits and limitations toward weather forecasting provides some hope in answering the question: is it going to snow this winter?

El Niño – Southern Oscillation (ENSO)

The ocean-atmosphere system is a coupled system, meaning that atmospheric changes can result in changes to the ocean and vice versa, oceanic changes can result in changes to the atmosphere. The simple definition for ENSO is a disruption of this normal sea-atmosphere relationship over the eastern equatorial Pacific Ocean. As already introduced, El Niño refers to a warm state of sea-surface temperature over the east equatorial Pacific. Conversely, La Niña (Spanish for "little girl") is colder-than-average east equatorial Pacific waters. El Niño/La Niña is the oceanic component of the coupled system.

Southern Oscillation defines the atmospheric component of the coupled system. The Southern Oscillation results from changes in average mean sea-level

pressure between two regions: 1) the western Pacific and Indian Oceans and 2) the central and eastern Pacific Ocean. The Southern Oscillation Index (SOI) is defined as the difference in sea-level pressure between Papeete, Tahiti (representing the central/eastern Pacific), and Port Darwin, Australia (representing the western Pacific). The strength of the Southern Oscillation is measured by the SOI.

The coupled ocean-atmosphere system forms a close relationship between El Niño/La Niña water temperatures and Southern Oscillation atmospheric pressure. A negative SOI indicates lower pressure over Tahiti when compared to Darwin, and a negative SOI typically coexists with warm east Pacific waters, i.e. El Niño conditions. By convention, these conditions are called a positive ENSO event. Conversely, a positive SOI (high pressure over Tahiti) usually coexists with colder-than-average east Pacific waters: a La Niña setup. These conditions are a negative ENSO event. When neither El Niño nor La Niña exists, then the conditions are called ENSO neutral.

These scenarios are meteorically consistent *(Fig. 1)*. ENSO positive (El Niño) conditions include warmer-than-average SST over the eastern Pacific. Warmer waters increase the temperature of the lower atmosphere resulting in increased lift (remember: warm air rises). Rising air is associated with lower pressure. For ENSO negative (La Niña), colder-than-average eastern Pacific waters create cooler atmospheric temperatures that result in sinking air and high pressure.

There is continued debate in the scientific community about what initiates an El Niño event. The evolution, however, is well documented. During ENSO neutral conditions, the trade winds blow from east to west across the equatorial Pacific. Warm equatorial surface water tends to move with the wind and pools in the western Pacific. Upwelling, or water being pulled up from lower depths, results along the eastern Pacific. These waters are cold and loaded in nutrients that create the rich fisheries along the South American coast. In the early stages of an El Niño event, the surface pressure begins to decrease over the eastern Pacific (i.e., negative SOI). Since wind wants to flow from high pressure to low pressure, it acts to slow the westward moving trade winds or even reverse the wind direction to flow toward the east. If these conditions persist for several months, the wind reversal begins to move warm equatorial waters toward the eastern Pacific, thus creating the El Niño component of the coupled ocean-atmosphere system.

Figure 2 shows ENSO events since 1950. It is not well understood what causes the strength and length of ENSO events. Sometimes they are short-lived, or they can last up to several years. Eventually, all events reverse back to ENSO neutral. Most often the coupled ocean-atmosphere system will transition into an opposite ENSO event, but not always. For example, in the 1990-1995 timeframe, an ENSO positive event from 1990 to 1993 transitioned into another ENSO positive event from 1993 to 1995. Also note that it is "normal" to be either ENSO positive or negative. Relatively short-lived ENSO neutral events are usually transition periods into another ENSO event.

ENSO Effects on Storm Track

The jet stream, or winds aloft, is a core of fast-moving air that typically moves from west to east and is strongest at elevations from 20-30,000 feet. Think of it as a river of air that circumnavigates the northern and southern hemispheres. As a rule, the jet stream is located vertically above the greatest horizontal change in atmospheric temperature near the ground. In Northern Hemisphere winter, the north-to-south contrast in temperature is greatest, and this is when the jet stream is strongest. In Northern Hemisphere summer, the north-to-south temperature contrast is weaker and located further north; hence the jet stream is weaker and moves north to Canada. Of course, the north-to-south

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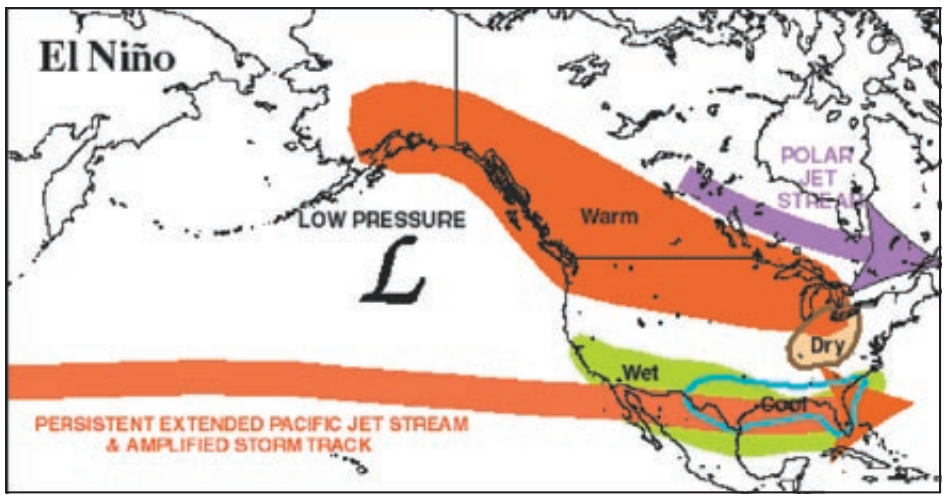

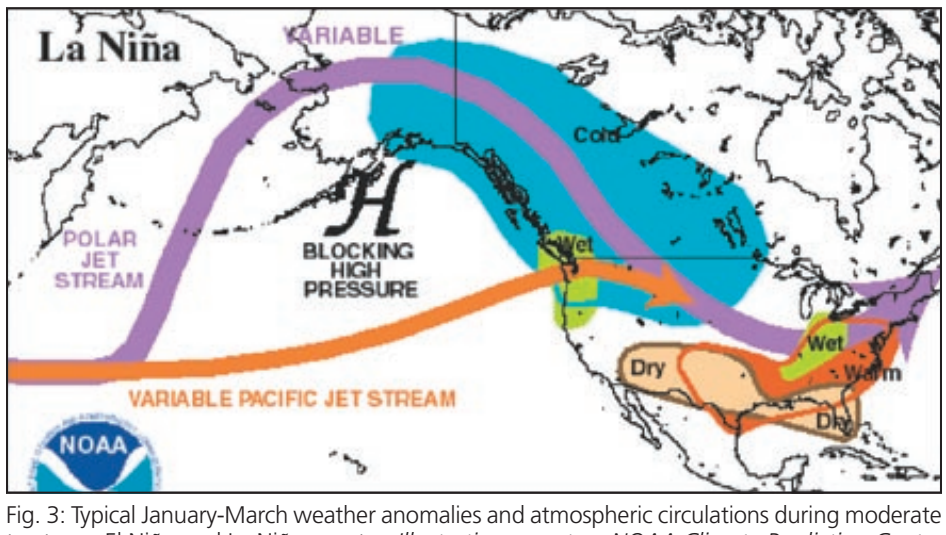

Fig. 3: Typical January-March weather anomalies and atmospheric circulations during moderate to strong El Niño and La Niña events. *Illustrations courtesy NOAA Climate Prediction Center*

ENSO Loads the Dice

Story by Wendy Morgan and Leigh Pender Jones

Howdy folks! Here we pass along an update on ENSO's impact for this season and the last. We'll start with a little reminder that at the beginning of the 2008/09 season we were in a neutral to weak La Niña, while for the 2009/10 season we have transitioned into an El Niño. As mentioned in John Snook's article *Seasonal Weather Predictability (at left)*, being in a non-neutral phase (i.e., either in an El Niño or a La Niña) simply alters the odds of getting a season of snowy bliss or snowless frustration. It's a bit like loading the dice. El Niño increases the chance for 1) cooler and wetter winters in the Sierra Nevada and Southwest and 2) warmer and drier winters in the Pacific Northwest and northern mountain states. La Niña, on the other hand, tends to deliver roughly the opposite.

For a quick 2008/09 recap, we ask: did the Niño's twin sis deliver last season? Well, La Niña basically flirted all season until finally giving up the goods only at the end – just in time to rid you Northwesterners of your blues. But she may not receive all the credit for last year's late-season gusto. Recall that there are other patterns and oscillations floating around the Pacific waters which impact snowfall across the West.

How Will El Niño Impact the West This Season?

And how has El Niño impacted the West thus far during the current season? Early season stoke levels rose as a few storms in the autumn brought snow to much of the West. It seemed that we in the north would evade El Niño's influence, at least for a time. However, by November and December, reality was starting to sink in. The Pacific Northwest went through a warm spell in December, and the northern-interior West simply went dry for much of the later fall. If your hills are in northern Utah, Wyoming, and Montana, you've likely spent more time in pits watching facets grow than you have spent skiing steep north-facing shots. But, while we in the interior have been sitting around comparing the size of our depth-hoar crystals, the Sierra has enjoyed a relatively steady season and are close to average.

It ain't textbook perfect, but this pattern more or less matches what we would expect to see during an El Niño. This fall we had just entered into a moderate El Niño, which has gradually strengthened into the winter. Most outlooks predict a continued strengthening until late winter. Seasonal predictions indicate that by season's end, much of the West should end up warmer than average, with the northern half being drier. The sad result is that seasonal snowfall in the Northwest and northern-interior West is likely to be less than average.

But, hey – chin up! Before you start sacrificing your most beloved skis for a blessing from Ullr, remember that you may still have a few golden nuggets to hang onto. ENSO only "loads the dice" for an epic (or dismal) season. You can still roll sixes even when the odds aren't in your favor. After all, the snow's still going to fly to some degree. And if nothing else, you can always ponder the question: Is bad skiing better than no skiing?

For those snow and weather geeks out there, check out www.cdc.noaa.gov/ENSO and www.cpc.ncep.noaa.gov for info and current conditions, if you haven't already.

Wendy Wagner (right), after just finishing her master's degree in atmospheric sciences at the University of Utah, is continuing her studies in mountain weather and snow science. Of course, data collection in areas sporting fine skiing is not an ulterior motive.

Leigh Pender Jones (left) recently completed her master's in atmospheric sciences at the University of Utah. She spends a few days a week in the office forecasting winter weather for UDOT, and the rest of the week poking around in the Wasatch snowpack.

From Bill Glude in Juneau, AK

We have been swinging back and forth from warm wet to cold clear here. Have decent cover at the ski area, but almost no snow in town. Ice skating is great though and we were heading out snow kiting today but the forecast breeze never came up so maybe tomorrow.

The jetstream has been doing really strange things and even though we should be in a series of cold winters our sea surface temperatures here are still warm. Storm tracks are looping all over north and south, splitting lows in two, being generally bizarre. But of course we all know there's no connection to human causes because Fox tells us so... :)

ENSO & MJO EXPLAINED

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temperature contrast is a constantly changing feature usually defined as cold and warm fronts. It is above these dynamic fronts that the jet stream flows, and it is where the most active weather develops and evolves with time.

Ocean temperatures affect the average location and strength of the jet stream. Therefore, anomalous changes in ocean temperature will alter jet stream location. ENSO events result in predictable effects on the seasonally averaged location of the jet stream and, hence, predictable changes in the seasonal storm track. For North America, the effects are most pronounced in the cold season. Figure 3 *(see previous page)* illustrates weather anomalies resulting from typical ENSO positive (El Niño) and ENSO negative (La Niña) events.

During ENSO positive (El Niño) events, warm eastern equatorial Pacific waters tend to enhance the north-to-south atmospheric temperature contrast. This contrast is further south and more concentrated than in an average year. The result is a Pacific jet stream that is further south and stronger than usual. The seasonally-averaged storm track moves south, creating above-average precipitation and cooler-than-average temperatures along the southern tier of states. A weaker polar jet stream results in below-average precipitation and warmer-than-average temperatures for the northern tier of states, southern Canada, and Alaska.

Warmer-than-average western equatorial Pacific waters during ENSO negative (La Niña) events tend to strengthen the jet stream over the western Pacific, but the eastern Pacific jet stream weakens and displaces north as it approaches North America. The result is a more active storm track into the US Pacific Northwest and British Columbia. Further south, below-average precipitation and warmer-than-average temperatures form along the southern tier of states. The active tropical weather over the western Pacific enhances the polar jet stream and helps to shape a blocking high-pressure pattern over the northeast Pacific. The polar jet stream flows north over the blocking high into Alaska. It then carries cold arctic air into western Canada and the northern tier of states.

It is important to point out that these are statistically averaged seasonal changes and have little effect on day-to-day weather events. The north will still get storms during El Niño events – just not as many over the course of a winter season. An anomalously strong storm or two can skew the statistics for an individual location and year. The bottom line is that for any given year, an El Niño event does not guarantee above-average precipitation for southern locales, but rather it will average out to above average over a combination of numerous El Niño events. An analogy is the amateur gambler who may feel good about a winning night at the Black Jack table, but eventually the gamer will lose in the long run.

To summarize, during an El Niño year, there is a better-than-average chance to receive above-average precipitation and below-average temperatures across the southern US, while the northern US and southern Canada receive below-average precipitation and above-average temperatures. Conversely, during a La Niña year, the southern US is more likely to receive below-average precipitation and above-average temperatures, while above-average precipitation and below-average temperatures are more likely for the northern US and southern Canada. Note that there is an intermediate zone, notably central Utah and central Colorado, where ENSO provides little seasonal predictability – i.e., there are about equal chances of receiving above- or below-average precipitation and temperatures for any given year.

Madden-Julian Oscillation (MJO)

The MJO is a phenomenon initially described in the literature by Madden and Julian *(1971, 1994)* as an oscillation in wind patterns over the tropical Pacific. It was originally called the 40-50 day oscillation, a timescale quite a bit shorter than ENSO events that can last up to several years. It is correlated with an eastward progression of tropical rainfall that develops over the Indian Ocean. There are similarities in the coupled ocean-atmosphere concepts used to describe both MJO and ENSO, with the primary difference being the shorter timescale. Current scientific research has revealed some interrelationships between MJO and ENSO. There is still a lot to learn, but MJO may play a role in the initiation and evolution of ENSO cycles.

Figure 4 illustrates a typical MJO life cycle. At first glance, there are many similarities to an ENSO negative (La Niña) event. And it is no coincidence that strong MJO activity is observed during La Niña and ENSO neutral regimes, and is weak or absent during El Niño episodes. During La Niña regimes, periods of heavy tropical precipitation develop in a 40-50 day cycle over the far western Pacific. This first phase of MJO is consistent with the warm western Pacific La Niña waters that promote rising air. The area of tropical precipitation travels east during the second phase of MJO, a movement consistent with eastward moving winds typical of La Niña. Upper-level flow – i.e., the Pacific jet stream – starts to carry a plume of moisture northeastward from the region of heavy precipitation. The area of heavy tropical precipitation continues its eastward progress during phase three of MJO. The Pacific jet stream, which typically flows into the Pacific Northwest during El Niño years, carries abundant moisture into this region. This scenario can lead to widespread heavy precipitation and flooding across northern sections of North America.

The Phase 3 MJO precipitation event has become known as the "Pineapple Express" for the large plume of moisture that extends from Hawaii into North America. Two recent events of note were December 2007 to February 2008 and December 2008, when MJO events contributed to extended periods of heavy snowfall over some areas of the mountainous west. MJO forecasts have proven valuable for providing a two- to four-week advanced warning of heavy wintertime precipitation events.

Is it going to snow this winter?

Weather forecasting experts debate every fall the implications of ENSO while trying to answer the question is it going to snow this winter. The interactions between ENSO and the other atmospheric oscillations make it a difficult proposition. To complicate matters further, the limits of predictability apply to forecasting ENSO events. Even if ENSO's effects on seasonal weather patterns were fully understood, forecasters must still predict if this winter will bring an El Niño or La Niña and then forecast what the results of the predicted ENSO will be on the upcoming winter weather.

Ongoing observations and research into these and other atmospheric oscillations continue to provide improved seasonal forecasts. As snow practitioners it is best to understand these phenomena and the limitations of seasonal predictability. With this foundation, snow practitioners can utilize publicly available observations and forecasts to prepare for an upcoming winter season. The National Oceanographic and Atmospheric Administration (NOAA) maintains several good Web sites with additional educational materials, expert discussions, current conditions, and predictions of MJO and ENSO.

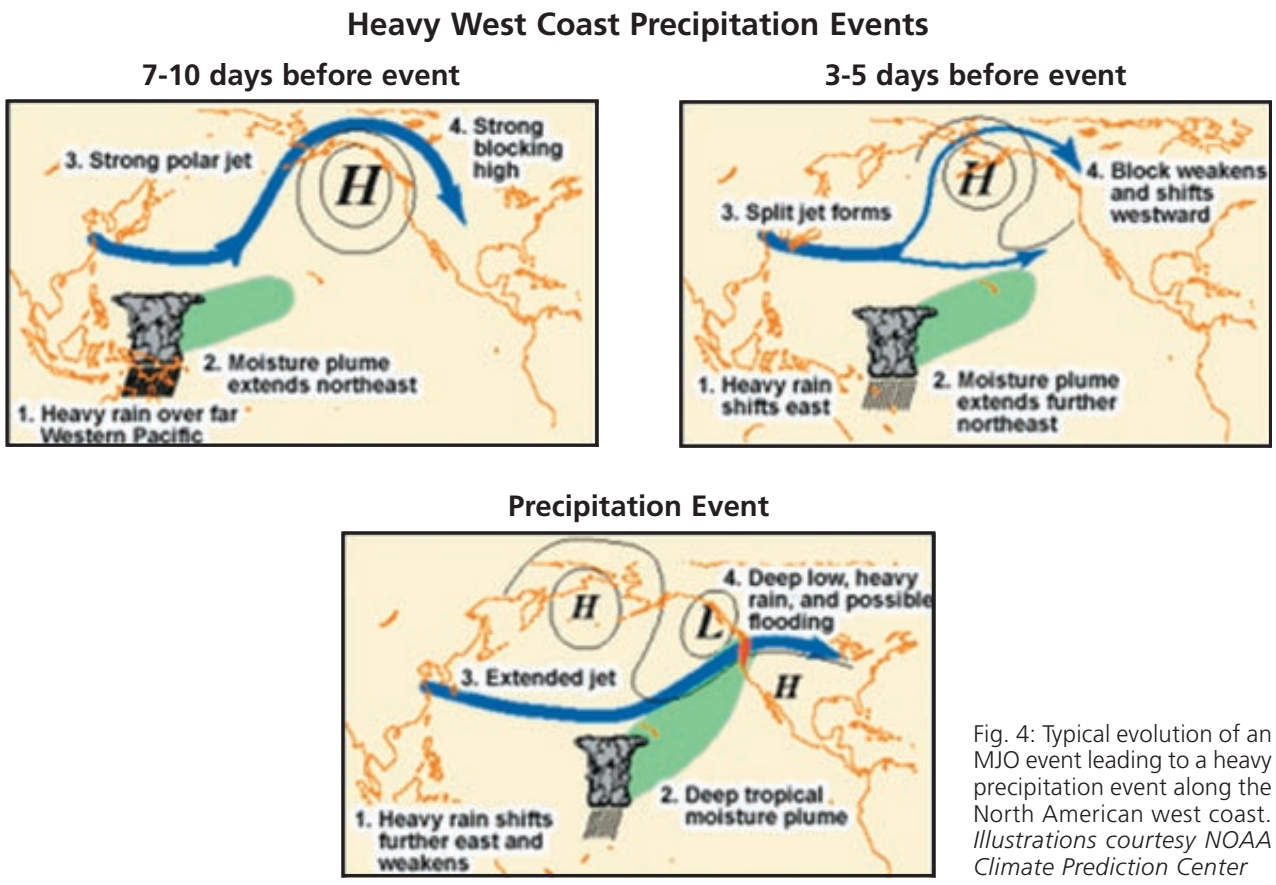


Fig. 4: Typical evolution of an MJO event leading to a heavy precipitation event along the North American west coast. *Illustrations courtesy NOAA Climate Prediction Center*

The primary NOAA ENSO site:
- www.elNiñoelnino.noaa.gov/

The NOAA Pacific Marine Environmental Laboratory ENSO site:
- www.pmel.noaa.gov/tao/elnino/nino-home.html

The NOAA Climate Prediction Center maintains ENSO and MJO sites at:
- www.cpc.noaa.gov/products/precip/CWlink/MJO/enso.shtml
- www.cpc.noaa.gov/products/precip/CWlink/MJO/mjo.shtml

References

Haltiner, G. J. and R. T. Williams, 1983: *Numerical Prediction and Dynamic Meteorology, 2nd Edition*. John Wiley & Sons. 496 p.

Lorenz, E. N., 1969: Three approaches to atmospheric predictability. Bull. *Amer. Meteor. Soc.*, 50, 345-351.

Madden, R. A., and P. R. Julian, 1971: Detection of a 40-50 day oscillation in the zonal wind in the tropical Pacific. *J. Atmos. Sci.*, 28, 702-708.

Madden, R. A., and P. R. Julian, 1994: Observations of the 40-50 day tropical oscillation: a review. *Mon. Wea. Rev.*, 122, 814-837.

Philander, S. G., 1990: *El Niño, La Niña, and the Southern Oscillation*. Academic Press. 293 p.

John Snook became interested in weather, snow, and skiing while growing up in New England anxiously awaiting the next nor'easter. He obtained a BS and MS in meteorology at the University of Wisconsin – Madison. John moved to Colorado in 1984 and worked as a meteorologist for 15 years at a NOAA applied research lab in Boulder. During that time, he completed a PhD in atmospheric science at Colorado State University. John then dabbled in private industry for several years before landing a forecasting position in 2006 at the Colorado Avalanche Information Center where he currently works. John has also worked as a part-time volunteer and professional ski patroller at Arapahoe Basin since 1985.

Positioned in the starting zone, Iron Man prepares for the blast. The trials were held in the northern Wasatch Mountains of Utah during April, 2008.

IRON MAN:
Steel Crash Test Dummy Measures Avalanche Forces

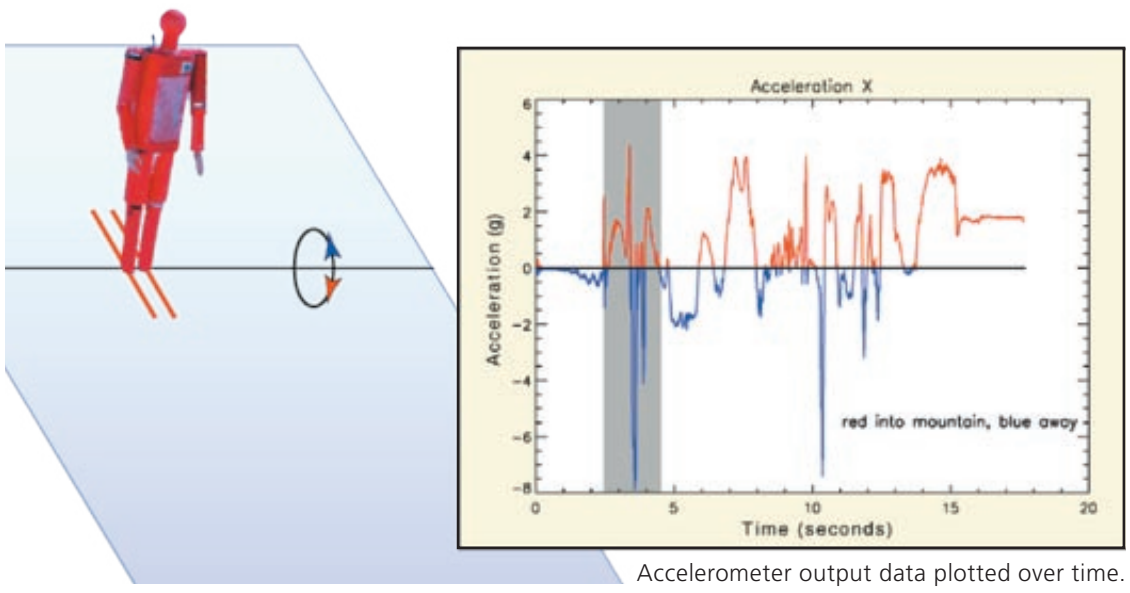
Story by Michael J. Jenkins, Timothy M. Samaras and John Sohl

A closeup of Iron Man reveals camera and instrumentation used to collect acceleration data during the experiment.
Both photos by Mike Jenkins

Applied Research Associates (ARA) worked with the Utah State Universisty on a National Geographic Television-produced documentary on the effects of avalanches on humans and implications for avalanche rescue.

Tim Samaras, a scientist with ARA, has spent his career analyzing disasters. His work has included using cameras to assess characteristics of lightning strikes, using sensors to gauge impacts of bomb blasts, and using probes to predict the path and forces of tornados. For the work described here, Tim teamed with Mike Jenkins of Utah State University to bring his expertise to measure what has never been measured – the forces imposed on an avalanche victim. The objective of the research was to determine the effects of avalanche motion on the human body and allow determination of acceleration, forces, the distance traveled, and depth of burial.

Iron Man is a steel mannequin, two meters in height, with a mass of 82 kg, approximating the size of a human male. A veteran of Tim's explosive experiments, Iron Man was built to withstand extreme forces. He is outfitted with sensors that measure pressure and impact to determine the trauma a human would suffer in a bomb blast. The challenge with this work was to adapt Iron Man to be an avalanche victim and transport him to an avalanche starting zone.



Accelerometer output data plotted over time.

Gary Ogg of ARA, who invented Iron Man, installed new instrumentation to measure avalanche parameters. The primary sensor was an accelerometer similar to those used to stabilize aircraft. The device measures acceleration, orientation, and roll in multiple directions. Iron Man was further modified with flexible joints to provide a more realistic representation of the human form. Iron Man was equipped with two video cameras to allow filming from the eyes of the victim. Once modified, Iron Man was taken from ARA in Colorado to Utah where he was fitted with skis for the avalanche tests.

Iron Man's partner was Foam Man, another crash test dummy with no electronic measuring devices. Outfitted with the Avalanche Airbag System (ABS), Foam Man joined Iron Man in the starting zone. The effectiveness of ABS is widely known and is available commercially in a variety of products.

The test was conducted on April 4, 2008. Prior to the test the snow study plot at near the experimental site received 50cm of new snow with 2.8cm of water for a snow density of about 6%. Ridgetop winds were moderate from the southwest preceding the test.

Iron Man and Foam Man were transported to the starting zone using ropes, then lowered in place after starting the electronic sensors in Iron Man and inflating the ABS on Foam Man. From an observation area below the path Tim set up a high-speed camera to record the event at 400-500 frames per second. Data from the camera allowed calculation of Iron Man's speed during the avalanche. A thermal-imaging camera was also set up to measure change in temperature of the moving snow due to frictional heating.

Once the victims were in place the avalanche was triggered using 12 kg of explosives. The resultant avalanche was classified as a SS AE, AB 2 I. Both Iron Man and Foam Man were caught in the avalanche and carried 137m vertically downslope. Iron Man was totally buried 30cm deep, while Foam Man remained on the surface. Iron Man stayed on his skis, traveling with the slab for 2.5 seconds before hitting a rock, losing his skis, and disappearing in the flowing snow. He reached a speed of 40 km per hour and rotated 11 times with a maximum of two rotations per second (120 RPM), experiencing an acceleration in excess of 10 times gravity. The thermal-imaging camera measured a temperature increase in the moving snow of 4-7 degrees Celsius.

At the peak measured rotation rate, the angular acceleration on Iron Man's head was approximately 4g. This is comparable to the forces routinely experienced by jet fighter pilots pulling out of a dive – but without the advantage of a pressure suit. Because of limitations on the rotational sensors (they were at their maximum values), the actual peak rotational motion was certainly larger, probably by a factor of 50% or more. With this conservative assumption, at approximately 3.6 seconds into his ride, Iron Man was pulling 9g of rotational acceleration at the same time that he was experiencing a linear acceleration in excess of 10g. To make matters worse, these accelerations were changing dramatically, a phenomenon known as "jerk." On impact with the rock, Iron Man's jerk exceeded 400 meters per second cubed.

Extensive physiological data exist on injuries sustained by American football players. The conclusion is that brain concussion depends most strongly on sudden changes in rotational motion of the head. The data from Iron Man implies that rescuers should assume that avalanche victims have been concussed. Likewise, cervical spine injuries should probably be assumed until proven otherwise.

This avalanche was relatively small, yet typical of resort-triggered avalanches and those involving humans in the backcountry. Although many people watched Iron Man take his ride and observed the point last seen, his final burial location was unknown. A ski was located during the initial search, and Iron Man was found with a probe within eight minutes after burial. His airway was exposed within 20 minutes. The rescue reinforces the well-known fact that it is bad to be buried. Even with professional rescuers standing by, Iron Man's airway was buried for 20 minutes, although he was only under 30cm of snow. Foam Man remained on the snow surface during the entire event, and his orange airbags were easily visible in the debris field.

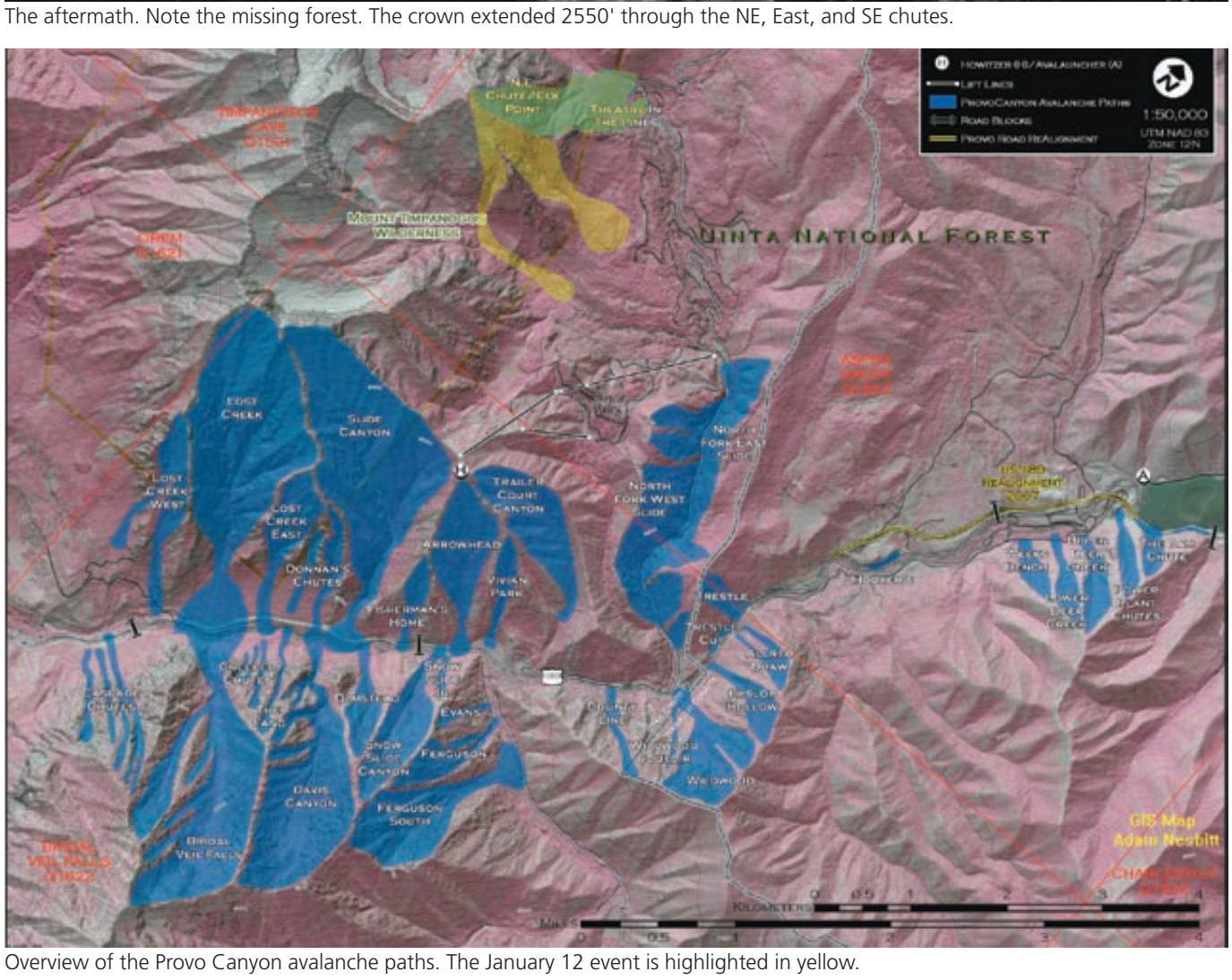
The Iron Man test demonstrated that existing technology can be employed to measure forces acting on avalanche victims. Many additional tests are required to fully understand the nature of forces experienced by avalanche victims across the range of conditions encountered in human-triggered avalanche incidents.

Mike Jenkins is a professor of forest science at Utah State University. Mike has worked as a patroller, snow safety director, and SAR dog handler. He currently works as a guide with Diamond Peaks Heli Ski Adventures in Utah.

crown profiles

January 12, 2005: Elk Point overrunning its normal boundary and heading right for us. It's time to run.

The aftermath. Note the missing forest. The crown extended 2550' through the NE, East, and SE chutes.



Overview of the Provo Canyon avalanche paths. The January 12 event is highlighted in yellow.

Remarkable Sightseeing in Provo Canyon

Story and photos by Bill Nalli

There are certain events that are etched in my memory: my first rock concert, the Michael Jackson Victory Tour; that over-the-head powder day on Halloween; the first date with my future wife. On January 12, 2005, an avalanche event on Elk Point in the Wasatch Mountains would leave a similar impression. While investigating a slide on an adjacent path, my partner Rip Griffith and I were treated to front row seats at an avalanche show of epic proportions.

Elk Point is located in the southern end of the Wasatch Mountains. It's at an elevation of 10,781' and defines the eastern boundary of the Mount Timpanogos massif. The southern end of Timp is home to two of the three largest avalanche paths in Utah that threaten a highway. It is the central focus of the UDOT Avalanche Safety Office in Provo Canyon. The third is Bridal Veil Falls on the south side of the canyon, which has its own infamous history. Each of these paths has a vertical drop of over 5400'. Along with big vertical relief, distinguishing characteristics of this part of the range are inhospitable terrain, low-elevation access points and runout zones, steep and rocky starting zones, and an often-thin snowpack.

Geographically, Provo Canyon runs southwest to northeast and connects the Utah and Heber Valleys. It is one of only four major routes that allow passage through the Wasatch, those being I-84 in Ogden, I-80 in Salt Lake City, US-189 in Provo, and US-6 in Spanish Fork. With 85% of the state's population living within 15 miles of the range, each of these routes play a big role in the lives of those 2-million people, and closing any one of them can cause considerable hardship. Provo Canyon is positioned in a way that makes it vulnerable to warm, moist storms from the southwest. When these types of storms continue for extended periods, we can see large destructive avalanche cycles in the Provo mountains. This is exactly the type of situation that led to the avalanche on January 12, 2005.

Some background to this event shows that the area was being primed for big things right from the first snowfall of the season on October 17. By November 1, we received 10.85" of water. Summarization of November and December: extended periods of cold, clear weather followed by big storms. A noteworthy SW wind event on December 19 produced a 10cm pencil-hard slab. By January we would end up with two layers of near-surface facets from the months prior, a hard-slab bridge, and a handful of significant avalanche cycles.

From January 3-12 we saw another four feet of snow with 7.09" water. Numerous large natural and artillery-controlled slides happened during this storm, but the one that left the biggest impression on me occurred just after it ended. With clearing skies and a strong veering wind, this day would allow our first look into the upper terrain in 10 days. The Utah Avalanche Center continued rating the danger as High and also commented, "Sightseeing may be remarkable today," "You need to think BIG when estimating potential runout zones," and "The potential still exists for large, long-running avalanches." Prompted by reports of good-sized slides, Rip and I went

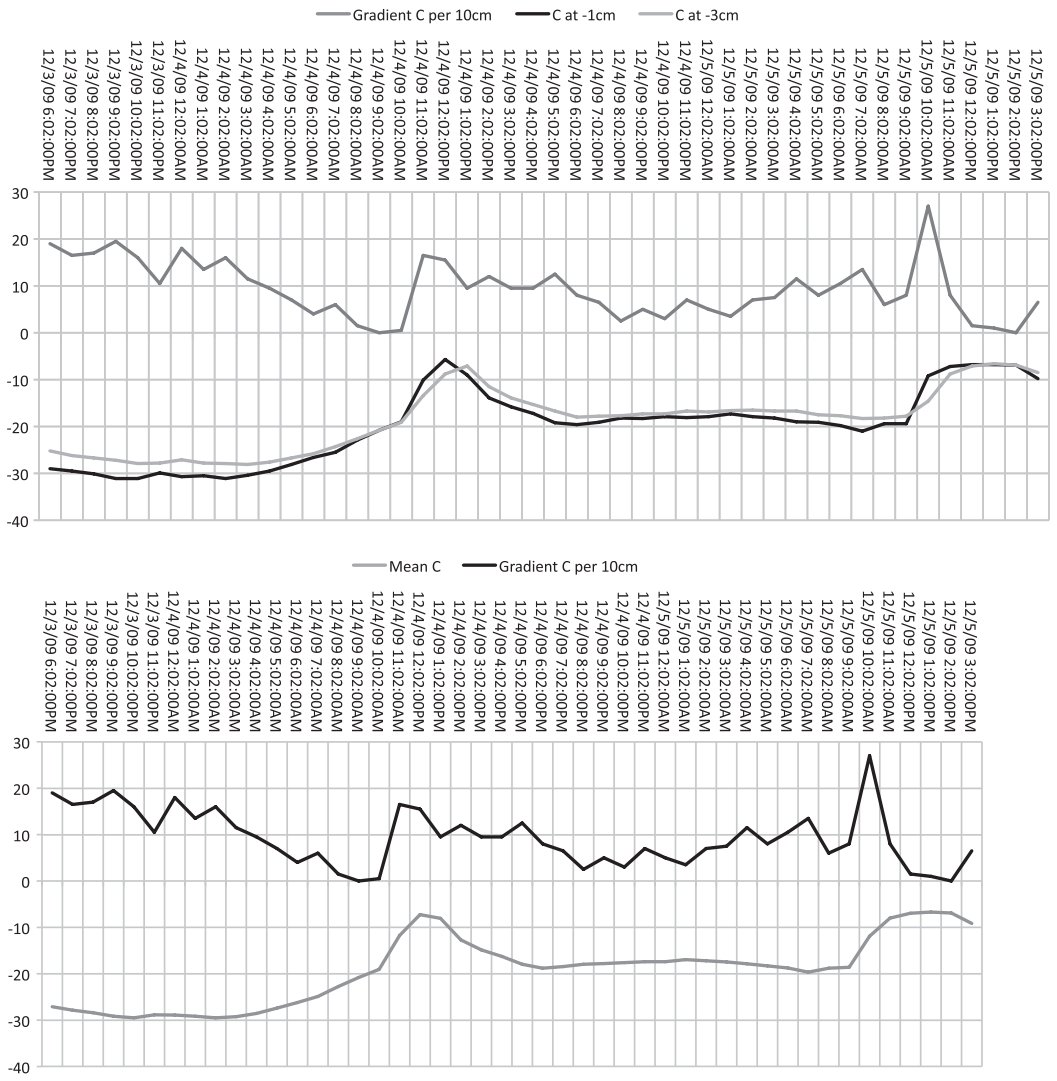
out looking to assess some of the damage.

The road past Sundance Resort ends in winter at Aspen Grove. Here there is a major trailhead up Timpanogos and also the runout of the NE Chute of Elk Point and numerous other large paths that funnel into Primrose Cirque. The NE Chute is the same path that took the lives of three young men who were hiking up its track on the day after Christmas, 2003 (pictured so vividly in the video, *Know Before You Go*). Adjacent to the NE Chute is a smaller path called Theater In The Pines, and this was our destination. A substantial slide that released here the day before left a big debris pile and flagged some pine trees. At its west flank, an obtuse ridgeline covered with dense conifers separates it from the NE Chute. Before this day I never gave too much thought to this ridge, and for that matter, we hadn't even mentioned staying out from underneath any of the big paths. It was just understood. We would soon find out that "underneath" is a relative thing.

After backing away from Theater In The Pines, we stood in an open meadow trying to get a look at the starting zone of the NE Chute through the clouds. I was attempting to get a photo of the intense windloading, when I noticed that the path had released and yelled, "Avalanche!" I snapped one more shot just as I realized that this thing was jumping that disregarded ridge and heading right toward us, fast. The next part happened for me kind of in slow motion. As I started running back to my truck, I took two steps and fell through the breakable wind crust up to my waist. I remember thinking, "You gotta be kidding me. Did I really just fall as the monster is chasing me through the forest?" We made it back into the truck and shut the doors just as the powder blast engulfed us and the entire meadow. Not knowing if we would be overrun, I sped off through the parking lot. We bounced off snow banks trying to see through the gray, nuclear winter happening outside, when we realized that we weren't in the main flow. Five minutes later when the dust settled we could see the extent of the damage. Not only did the NE Chute avalanche, but the crown extended to the east through two more separate paths spanning 2550'.

In total, the slide descended 3800' vertical, destroyed 10 acres of mature conifers, and downed numerous other trees several thousand feet past the toe of the debris – all without injuring a single person. I classified it as HS-N-R5,D4+-O with a crown 4-8' deep that failed at what came to be called the November facets. I counted 95 rings on the largest tree destroyed, but I think it's been far longer than 100 years since anything of that scale has happened on this path. One thing I'm sure of, this slide has forever changed my perspective. As much as I love seeing and making avalanches, I hope this is the closest I get to something of that magnitude again.

Bill Nalli is currently the director of UDOT's avalanche program in American Fork and Provo Canyons. He is a former Solitude ski patroller and backcountry ski guide. When he's not geeking-out taking pictures of everything with his camera, he might be found trying to get up to the front row of some rock concert or climbing a desert tower with his wife and one-eyed hound dog. ❄



Provo Canyon Weather Charts

Data and overview by Brett Kobernik

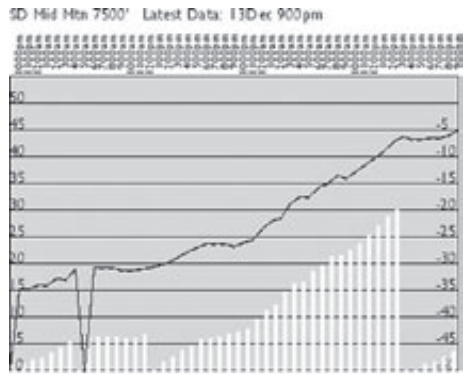
The above charts show the formation and growth of the weak layer underneath the slab in the widespread mid-December 2009 avalanche cycle. The photo on the cover is one of many avalanches that occurred in this cycle. See the UAC Web site for more photos and information: http://utahavalanchecenter.org/services/avalanchelist. The above dataset shows a snow temperature profile during the cold spell where faceting was occurring. (http://utahavalanchecenter.org/snow_temp_profile_albion_basin_12052009)

Note that the gradients in the top few cm are quite steep, averaging 100C/M to 250C/M! Also note steep gradients with the diurnal swing. The gradient is the difference between the -1cm sensor and the -3cm sensor. One graph has the mean temperature and the other has the actual temp for each individual sensor. The cool thing about the latter is that you can see the diurnal shift.

While the mean snow temperature is quite cold, and we're told things happen slower at colder temps, manual observations during this period confirmed how fast the surface deteriorated. The natural cycle that followed also verified things nicely.

At right is a Sundance chart to accompany the Provo Canyon avalanche info from Bill Nalli, showing new snow and H2O from that storm for a 48-hour period.

My assistant on the datalogger project, Wendy Wagner, is also working on graphing options. ❄



Why Teach Searching in Parallel?

Story by Bruce Edgerly

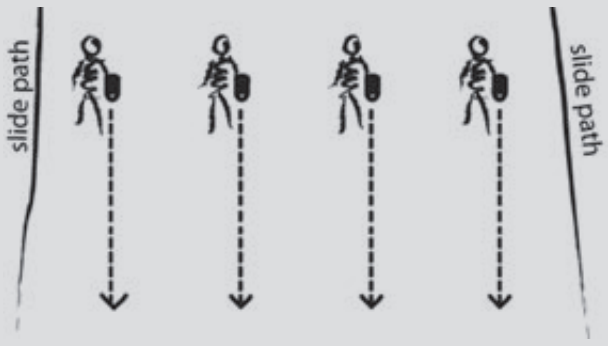
The Avalanche Review apologizes to Bruce Edgerly for the omission of this sidebar to the article "Searching in Parallel," TAR 28-2.

We've spent years training ourselves, our reps, and our distributors how to do epic multiple-victim beacon searches with four or more transmitters all buried in close proximity. We do this mainly so we can train guides taking certification exams. This has been quite a commitment considering the extremely limited number of cases where these techniques would ever apply *(see "Digging Deeper: Uncovering the Real Issues in North American Multiple Burials," TAR 27-2)*. It's also very time consuming. But when we started doing the same scenarios as a group rather than as individuals, it took a fraction of the time. And it gives our reps the chance to organize a rescue, which is always an extremely valuable experience. So we've changed our training focus at BCA from complicated individual scenarios to more applicable skills like strategic shoveling and group rescue.

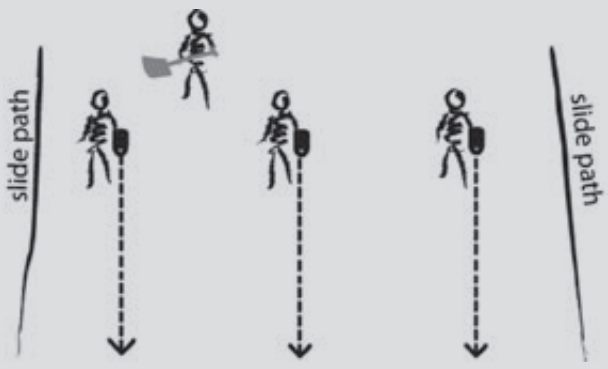
If somebody is training to locate several avalanche victims at a time, then he is making an important assumption: that others are available to shovel while he continues searching for the next victim. Otherwise, he must start shoveling as soon as he locates the first victim. So we kept asking ourselves, "If there's shoveling manpower available, why wouldn't you harness this manpower to help with the beacon search – especially now that beacons are so easy to use?"

Ethically speaking, searching in parallel as a group is also fairer to the victims than searching in series as an individual. The victims' survival chances are equalized, since the first victim found is no longer the focus of the recovery effort. If there's limited manpower then there's no choice but to focus on the first signal. But with adequate manpower, it makes sense to give everyone an equal shot at recovery.

Finally, it's important to remember that shoveling manpower is almost always the crux in an avalanche rescue. You should have at least two shovelers per victim if that victim is buried more than a meter deep. If you don't have this kind of manpower, then your only choice is to search in series, excavating each victim as you go. There's no sense searching in parallel if you can't shovel in parallel too. That's why searching in parallel should only be taught to those traveling in groups of four or more (such as SAR teams and commercially guided groups) or where others equipped with beacons can be recruited to take part in the search (select ski resorts). Searching in parallel is probably already being taught at some levels in various forms, under a different name. But to my knowledge, it has not been formalized, so this is a start.



Once a victim is found, at least one searcher begins excavating while the others continue the search, using a readjusted search-strip width, if necessary.



Bruce Edgerly is vice president and co-founder of Backcountry Access, Inc. (BCA), a leading manufacturer of snow-safety equipment, based in Boulder, CO. He and Dieter Stopper presented "Searching in Parallel" as a poster at the 2009 ISSW Europe conference in Davos, Switzerland. ❄

Mount Baker

Photos by Garrett Grove

Garrett Grove captured these monochromatic images at Mt Baker ski area in Washington's North Cascades. These events were precipitated in December 2009 at 5000' when 2-3' of new snow fell on a persistent weak layer created by a two-week cold snap. All these avalanches were set off sympathetically by pro patrol bombing down canyon.

The guard station built by the CCC in the fall of 1937 (left) didn't last one winter at the base of Bald Mountain's prolific avalanche paths (above).

The two shots below present the scene that greeted the returning ranger in the spring: a "pile of sticks" was all that remained of the cabin.

Photos courtesy Wasatch-Cache National Forest.

An Unfortunate Set of Circumstances

An early history of avalanches in Utah's Western Uinta Mountains

Story by Dave Ream

It was 1937, and America was slowly and begrudgingly working its way out of the great depression with Franklin Roosevelt's New Deal policies and programs. The Civilian Conservation Corps (CCC) and the Works Project Administration (WPA) were putting Americans back to work and back on their feet all over the country.

This story takes place in one such area in the Western Uinta Mountains in northern Utah. For the people of northern Utah, the Western Uintas were essentially right out their back door and begging to be explored. Several years before, the CCC and WPA had pioneered a new road into the heart of this beautiful area. Hard-working people had a little more money in their pockets and a yearning to get out into the great outdoors. Consequently, people poured into this area by the thousands, excited to explore the hundreds of crystal-clear lakes teeming with trout and dozens of 12,000' peaks begging to be climbed.

The fledgling Forest Service had just taken over managing this area. With all this new interest and increased activity, the agency decided to build a guard station for a ranger and his family. This would allow the Forest Service to look after its interests in this burgeoning recreational Mecca.

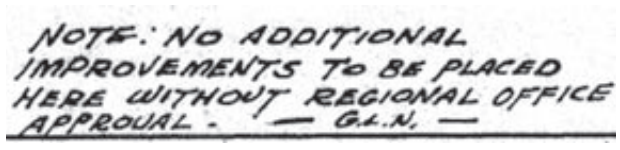
Plans were drawn, site locations were investigated, and a beautiful open meadow below the northeast shoulder of magnificent Bald Mountain was chosen as the location of the guard station, work center, and grounds. The site was an open glade with widely dispersed large conifers and wide-open vistas of the surrounding mountains and terrain. In fact, very few trees even had to be cut down or trimmed for the site plan to nestle into this idyllic spot. Unfortunately, the architects failed to recognize the looming avalanche path and the obvious signs that indicated that this place got clobbered from time to time.

The Forest Service did recognize the threats posed by avalanches. During the same time, the Salt Lake winter sport association and the Forest Service were planning to soon open Alta ski area. The Forest Service hired Alf Engen to design the new ski area and quickly hired Alf's brother Sverre as the agency's first snow ranger whose work was to grapple with the significant avalanche problems associated with the new development. Unfortunately, it never crossed the Forest Service architects' minds to consult with these early avalanche experts regarding the Mirror Lake Guard Station.

Later that summer, the site was staked, lumber from the local saw mills was trucked in, and the plans were finalized. CCC carpenters and laborers arrived that fall and completed a wonderful guard station and work center. As the snow began to fly, the new guard station was boarded up and the ranger left, excited to return next spring with his family for a summer working in this magnificent country.

Well, as you might expect, the winter turned out to be a wild one. Large snowfalls, cold temperatures, long dry spells, interspersed with high winds led to disaster for the guard station and grounds. The ranger came back in the springtime to find that a large pile of sticks was all that remained of the new buildings.

For the next several years the Forest Service struggled with what to do next. Finally it was decided to abandon the site and move the station to a safer location closer to Mirror Lake. In the fall of 1940 the regional architect ironically scribbled the following at the bottom of the site plans:



Dave Ream writes: As far as our winter, we've had one good snowstorm and significant avi cycle, but that's all. Dribs & drabs otherwise. Our Colorado-like snowpack is slowly weakening again. It's clear and cold today, and I can hear the surface and near surface facets growing. From Brett's report this morning, two parties triggered slides again yesterday with people taking short rides. It's still out there! The next good storm with significant water weight is going to start the cycle over again. Isn't snow great! Being a snow geek is never boring.

Dave Ream isn't just a snow geek.

Author Peter Carse billy goats through Northwest Passage at Bridger Bowl in search of avalanche hazard on a control morning.
Photo by Luke Rice

The Scoop on Schlasman's:
New Terrain at Bridger Bowl Presents Ski-Area Challenges

Story by Peter Carse

Editor's note: Schlasman's lift and Slushman's drainage are named for P.B. Schlasman, one of four German coal miners who were the first documented avalanche victims in the Bridger Range on February 10, 1885.

In December 2008, Bridger Bowl ski area opened over 300 acres of new, lift-served, technically difficult avalanche terrain and, for the first time, provided broad access zones to the National Forest lands beyond the ski area boundary. This article outlines some of the challenges introduced by these changes and some of the strategies implemented to deal with them. To understand the reasoning behind Bridger's arguably unorthodox solutions, it may be helpful to review a little history.

Bridger Bowl, located 15 miles northeast of Bozeman, MT, came into being as a nonprofit community ski hill in the 1950s, with a surface lift up a broad shoulder on the east side of the Bridger Range. This provided access to good skiing in bowls that are the runouts of avalanche chutes originating from the crest of the range. Early avalanche work amounted to little more than occasionally cutting the large cornices that form all along the ridgeline and firing a few rounds from the 75mm rifles into the North and South Bowls, Avalanche Gulch, and Northwest Basin. Following the installation of a chairlift in the late '60s that brought skiers to within 400 vertical feet of the ridge crest, the upper terrain was opened to the public for hiking access in the early '70s. This avalanche terrain within Bridger Bowl's permit area extended for nearly a mile along the east side of the Bridger Range and became known as the Ridge with a capital R.

At first, few customers ventured into this terrain. Although there was an increasing amount of avalanche-mitigation work done by the ski patrol, many pockets of unstable snow were presumed to remain. Beginning in the late '70s, Ridge hikers were required to wear a transmitting avalanche beacon, to reduce the time needed for a ski patrol rescue should an avalanche occur. Beacons were, and still are, checked at the "beeper checker" at the Ridge access point.

In the early days, opening the Ridge to the public remained a very low priority, and sometimes it would be closed for days following a storm. Increase in public use was gradual, and a distinct management plan for the Ridge evolved, encouraging responsibility and accountability on the part of the paying guests. In a departure from ski-area trends at that time, the terrain was left in a more natural state, with no signs, internal closures, bamboo, hi-viz, or pads to warn or protect the public from the many hazards.

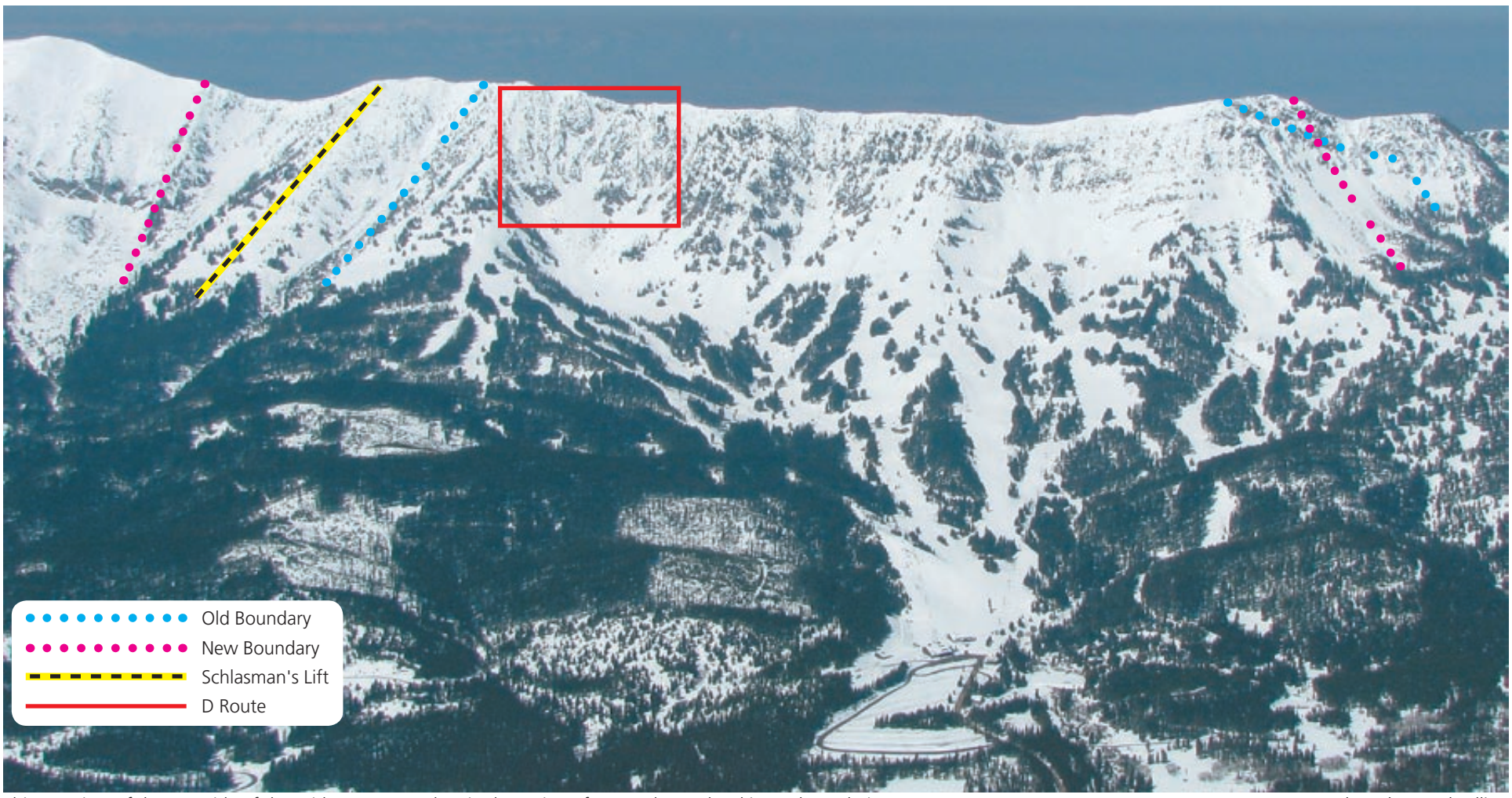
By the time of the changes last year, the Ridge was home to over 100 named avalanche paths, the ski patrol had accepted a role of pursuing "very active" avalanche-hazard reduction efforts, and Ridge enthusiasts – often over 1000 a day – had become accustomed to the terrain opening shortly after 9am, even on storm days. Access from the ski area to the adjacent National Forest lands was limited to gates low on the mountain, just below the avalanche runout zones of backcountry slide paths. The Ridge was pretty much "tracked out" by noon on a powder day.

The Schlasman's expansion on the south side of the ski area for the 2008/09 season added 311 acres of "Ridge-style" terrain, with over 25 new avalanche paths to deal with. At the same time, the 75mm recoilless rifles were retired, necessitating the development of a new hazard-reduction plan for the area above the South Bowl known as "D Route." On the north side of the ski area, avalanche work on the northern half of the so-called "Northwest Passage" area was abandoned, and the (now-open) ski-area boundary was readjusted to the south.

Four new ski patrol positions were created to deal with the added avalanche work. Two patrollers were assigned to the remaining inbounds NW Passage area to enable it to open on a daily basis along with the rest of the Ridge, rather than being delayed a day or more as it had been in the past. The other two patrollers were assigned to D Route, joining the two former gunners to deal with the 23 paths above the South Bowl in one or two passes, accessing the area via the new lift to the south. The new terrain itself, containing 29 avalanche paths accessed by the new lift, was dealt with as four distinct routes, covered by patrollers after they had finished with other routes. This meant that on any day with an avalanche concern, the new terrain might open late or not at all, depending on conditions.

Ski-area management adopted a policy of managing the new Schlasman's area as Ridge terrain. This meant that each skier would be required to wear a transmitting avalanche beacon in order to ride the lift. It was highly recommended that skiers be familiar with the terrain, stay with a partner, and carry a shovel and probe as well. The complex technical terrain, like the rest of the Ridge, would be devoid of signs, in-area closures (such as cliff areas), and hazard markings. The historical precedent of the transceiver requirement facilitated an easy transition to this being a requirement for our guests to ride the new lift.

Concurrent with the opening of the new lift-served Ridge terrain, zones were designated allowing egress from the Ridge to National Forest lands beyond the ski-area boundary. This – after years of discussion and negotiation between area management, the board of directors, and the Forest Service – allowed easy and immediate access to often-dangerous backcountry



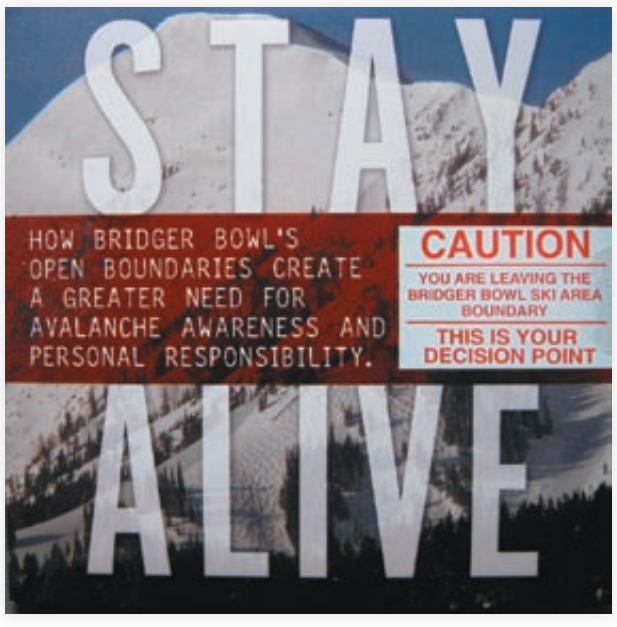
This overview of the east side of the Bridger Range, taken in the spring of 2008, shows the ski-area boundaries. *Photo by Randy Elliott*

This head-on shot shows the new acreage that was opened for the 2008/09 season. The photo was taken during the 2007/08 with deeper-than-average snow coverage. All the terrain shown here is now inbounds, accessed by the new Schlasman's lift that runs right up the ramp in the center of the photo, ending just short of the summit. *Photo by Doug Wales*

avalanche terrain by ski-area patrons of all ages. This is an important point to keep in mind when considering the transceiver requirement. In order to directly access backcountry avalanche terrain from the ski area, enthusiasts must first gain access to open Ridge terrain where a transmitting avalanche beacon is required. As a result, the individuals who choose to cross the ski-area boundary via these access zones – and possibly become involved in a backcountry avalanche incident – can be assumed to be beeping. Should their self-rescue falter, this solution considers some other players. Victim's families and friends, as well as the volunteer rescuers and their families, would be able to hope for a more timely resolution to the situation if a recovery could be made through a transceiver search rather than potentially drawn-out probe line searches.

As part of the overall new boundary policy package, Bridger Bowl invested hugely in educating the public about the dangers of leaving the ski area. Working with the Gallatin National Forest Avalanche Center, Bridger Bowl got the word out through articles in local newspapers and magazines, the Internet, schools, and through a free educational video distributed to every person obtaining a season pass.

In the new terrain accessed by the Schlasman's lift, a heightened appreciation emerged for proficient skills in high-angle technical rescue. Due to the nature of the



Bridger Bowl invested heavily in public education regarding the risks of accessing the backcountry from the ski area, including distributing this free DVD to season pass holders.

rocky chutes and cliffs, there are several areas where the rescue of a guest with any injury involves lowering a toboggan over vertical drops. Even without associated injury, some enthusiasts may tumble or otherwise find their way into a spot where they no longer feel safe moving in any direction. These uninjured folks are assisted by the ski patrol by being lowered, raised, or short-roped to safety. Anticipating these situations prompted more focused technical rescue training for the ski patrol, along with the acquisition of more rescue gear and the installation of solid anchors in a few key locations.

As the 2009/10 season gets under way, we at Bridger Bowl are excited to continue to refine our avalanche and technical-rescue programs in the new terrain. We are striving to be on the carving edge of snow science in our ongoing exploration of the "human factor" as it relates to personal responsibility, with in-bounds extreme terrain as well as side-country decision-making.

Additional information about Bridger Bowl's expansion and boundary policy, including maps and photos, may be found by visiting bridgerbowl.com and mtavalanche.com/sidecountry.

Peter Carse learned to crawl through the snow in northern Vermont. This led to a career of ski patrolling in the West starting in the early '80s, most recently with the Bridger Bowl patrol in Bozeman, MT. ❄

Inbounds Incidents & Fatalities 2008/09

Story by Doug Abromeit

Editor's note: When Doug Abromeit sent this article, I was curious how snow-safety crews strategize to combat the deep-slab problem. On pages 27-28, Scotty and Sterbie offer detailed and terrifying perspectives from behind the fuse.

An inbounds avalanche triggered by a patroller's bomb overwhelmed the Bridger Restaurant at Jackson Hole Mountain Resort on December 29, 2009. Fortunately, no restaurant workers were injured in the incident, although seven patrollers were partially or completely buried, including one patroller and his dog trapped in the single-door patrol room. *Photo by Ray Spencer*

Winter 2008/09 will remain forever etched in the psyches of many US ski patrollers and avalanche professionals as the winter inbounds avalanches tragically killed three skiers and buried as many as a dozen others in December; an explosives-triggered avalanche buried but mercifully did not injure four patrollers the same month; and, very sadly, another explosives triggered avalanche in March killed a patroller in the line of duty.

These events clearly reminded all of us of three obvious and indisputable facts:

1. Snow is an extremely complex, variable, and hard-to-predict medium.
2. Conducting avalanche control including using explosives can reduce the avalanche risk to almost zero, but it cannot eliminate it.
3. Avalanche control is dangerous work.

We know weather is the carpenter of snowpacks, and in 2008 it laid down a lousy foundation. Several warm storms descended on Western mountains in early November, followed by high pressure mixed with occasional snowfall and relatively cold temperatures. The storms and high pressure created a shallow pack typically composed of rain crusts, facets, and wind slabs. This bad brew set the stage for the unprecedented number of fatalities and incidents when snow finally began to fall in earnest in mid-December.

The first fatality happened at Snowbird on December 14, the second at Squaw Valley on December 25, and the third at Jackson Hole on December 27; numerous incidents and close calls, including full burials, occurred in several ski areas during the same period. All the December fatalities and incidents occurred in open areas, involved weak faceted basal layers, and were post-explosives control releases.

The ski industry and avalanche community spent the past year reflecting on and analyzing the December 2008 and March 2009 events, including sponsoring meaningful presentations and discussions at both the Utah and Colorado Snow Avalanche Workshops in fall '09. The Utah workshop highlighted presentations by Jackson Hole and Snowbird snow safety directors and the Colorado workshop included a presentation by Montana State University professor Dr Dan Miller. The Jackson and Snowbird snow safety directors described and answered questions from other professionals concerning avalanches at their resorts, and Miller focused on how explosives affect the snowpack. The FS National Avalanche Center is working with the National Ski Areas Association, the Avalanche Artillery Users Committee, and others to support continued explosives research like Miller's, including why post-control releases occur. Better understanding of explosives will enable control teams to more effectively utilize this vital tool.

The US ski industry typically has around 57-million skier visits each year; the NSAA estimates that about 15% or 8.5 million of those visits include skiing open non-groomed runs on terrain steep enough to avalanche. The statistical odds of being killed by an avalanche inbounds during the winter of 2008/09, one of the worst in the history of the US ski industry, was one in 2.8 million. While the risk is statistically miniscule, it exists, and the ski industry takes the risk very seriously.

There is only one way to assure there will never be another avalanche fatality in an open area in a ski resort and that is to prohibit skiing on or beneath slopes steeper than about 30 degrees. Obviously, that is not going to happen. And since it is not going to happen, the industry will continue to develop better mitigation techniques to reduce avalanche risk even more effectively.

Those mitigation techniques must include not only forecasting and control components but also emphasize good ski-area planning. Good ski-area planning discourages structures being built in locations that could be struck by avalanches that occur naturally or are triggered by active avalanche control.

It is true that restricting structures containing inhabitable spaces like restaurants and retail sales to locations that could never be affected by avalanches is literally impossible in many ski areas. Since that is the case, good ski-area planning dictates that all structures be built to withstand a design avalanche, that all are constructed in locations unlikely to be hit by an avalanche, that the avalanche danger to the structure can be reasonably mitigated, and that the ski area operating procedures either do not allow the structure to be inhabited during avalanche-control operations or severely restrict habitation to essential personnel. If it is necessary for essential personnel such as ski patrollers or lift operators to inhabit a structure at risk during avalanche control, they should be restricted to the most secure section of the structure when avalanche danger or control could affect the building. Members of the public should never be allowed in structures at risk of being struck by a naturally occurring avalanche or one triggered during avalanche control. It is requisite that applicable oversight agencies including county building departments and the Forest Service – along with a disinterested, knowledgeable third party specializing in avalanche mitigation – agree on what constitutes a design avalanche for a particular location.

Allowing structures in locations that will likely be struck by avalanches also tends to put increased pressure on ski patrols to protect the structure and may subject them to increased danger. Additionally, good planning, good sense, and basic avalanche awareness dictates that ski patrols should always have safe and reasonable lift-served access to avalanche terrain; ski patrollers should never have to expose themselves to danger hiking uphill through avalanche terrain in order to work their way downhill mitigating the danger.

Good ski-area planning also necessitates that any decision involving whether the avalanche risk has been reduced to the point that it is prudent to open terrain to the public should be made by the snow safety director/avalanche mitigation leader. Economic issues and considerations other than safety should not be factored into that decision.

All ski areas that contain avalanche terrain should consider listing avalanches as an "inherent risk of skiing" (many ski areas already do this). And ski areas should also consider providing basic avalanche-awareness information such as always riding with a partner, watching and keeping track of one another, having a Recco chip or similar device, and perhaps wearing a transceiver and carrying a shovel.

The public has always been attracted to ski areas with steep, exciting terrain. Recently improved equipment has stimulated that attraction and increased subsequent demand. As a result, many ski areas have expanded into or otherwise opened steeper, higher-risk terrain. Increased acres of steep terrain, of course, equals increased avalanche mitigation and exposure for ski patrols.

It is true that ski patrols will probably never be able to totally eliminate avalanche risk. Nevertheless, it is incumbent upon the ski industry to continue to financially and otherwise encourage efforts including workshops, studies, and research and development to make avalanche mitigation as effective and as safe as possible. Doing so will increase the odds that new, innovative techniques will be developed that could ultimately reduce the risk to both the public and to ski patrol avalanche-control teams.

This Christmas Day inbounds avalanche *(above, at right)* took a life at Squaw Valley. *Photo courtesy Squaw Valley ski patrol*

Doug Abromeit works for the Forest Service National Avalanche Center.

Right Trigger, Right Place, Wrong Time

Story by Scott Savage

This slide in Liberty Bowl occurred during a busy holiday afternoon at Big Sky resort. All nine skiers on the path when it released escaped without incident. *Photo by Josh Porter*

Like many avalanche professionals, I've developed a love-hate relationship with deep-slab avalanches over the years. I love the challenges associated with deep-slab operational forecasting. I really love watching the big ones rip from up close, feeling that guttural rumbling as they churn down the hill, listening to rocks clattering as the powder cloud fills the air, and finally experiencing the deafening silence as the dust begins to settle. But I hate when a voice on the ski patrol radio says, "Hey Scotty, there's a big slide in Liberty happening right now," at 1:30 in the afternoon the day after Christmas. While it's open.

That is exactly what happened a couple winters ago at Big Sky Resort in Montana. On one of the ski area's busier days, the most popular run on the south face of Lone Mountain pulled out when one of nine skiers on the slope remotely triggered it.

I vividly recall surveying the scene. Acres of 3-12'-deep debris. About what I expected to see, but surreal nonetheless. Public milling around the area. Beacon and hasty searches underway. Dog teams, Recco searches, probe lines on the way – check. A sleepless night to come – check. "Bomb dirt" all over the debris, shot craters in the bed surface – check. How and why did this happen?

Amazingly, all nine skiers on the slope that afternoon were above the 250'-wide slab that released in Liberty (Stutzman's) Bowl that day (HS-ASr-R4-D3). This stubborn, 33-degree angle path had only pulled out a few times in the previous 30 years and was the last major path on the south face to fail on a nasty crust-facet combo that year. It wasn't a big surprise that it went, but it was definitely a surprise that it went in the middle of the afternoon, 11 days after we opened it, with over 2000 tracks in those 11 days, with no overnight loading to speak of, with the previous days' five-pound surface shot hole there for all who skied it that day to see, and with surface conditions consisting of cut-up powder and soft moguls.

That season, we had treated the path as if it were that really cute girl everyone wants to date, giving her all the attention and respect that she deserves. More than ever before, actually. But she played hard to get and was a fickle one.

We opened the path after a 12-day window of stable weather and numerous pits, stability tests, and surface blasts. We made it through those first couple nervous days – *phew*. Then lit it up whenever it got a decent load. Nothing. Shot it again on Christmas Day with about a foot of 4% fluff. "This isn't gonna do anything, but what the hell, we're here," I said to my route partner as I set a double on an "Amble stand" of snow a foot above the surface. Still nothing. That night, the wind moved some snow around on the upper reaches of the mountain. On that next fateful morning I had one of the patrol's ace deep-slab hunters do a second lap to check it with a pack full of doubles and triples on sticks (bamboo). "Nothing going on in Liberty:soft bumps, shot holes, and bomb dirt." And this guy loves the smell of dynamite in the morning. Sounded good to me. I moved a little lower in a nearby path so I could see the Liberty Bowl starting zone: looked good to me. Wrong.

What did we do right?

We opened the suspect slope during a good-weather window with a minimal 7-14 day new load following extensive observation, digging, banging on columns/sliding saws through weak layers, and explosive testing. We paid close attention to cumulative loading in the path. We had experienced workers who had been around for years and had triggered or investigated previous slides there, leading most of the explosives testing missions before and after it was opened. We weren't afraid to tell management, "We need to do a bunch of blasting and keep Liberty closed today," but we never got either the good stiff load or bad gut feeling that would have prompted this action. After 11 days and thousands of tracks, I didn't feel we were getting complacent, but it didn't matter. Fortunately we got lucky.

What would I do differently?

I would gladly write a $1000 check today to see what a double on a stick on the edge of the slab that failed, about 50-100' below the crown, would have done that morning. And I'm not wealthy. I would pay more attention to mixing up shot placements, making sure to test the thinner slab borders extensively. Especially given the dramatic propagation events (multi-path or wider than normal activity, sympathetic releases, remote triggering) we observed on steeper paths with similar snowpack structure that year.

On the relatively rare occasions that we deploy big ANFO shots, it is typically immediately following big loading events. In this case, a robust early December storm kept us busy for five days post-storm before we were able to visit Liberty Bowl for the first time. We discussed dropping off a big shot on the initial hazard mitigation/explosives testing mission but opted to go with several smaller shots instead. Would a 50-pound shot have triggered the path then? Or had the slope stabilized enough at that point that nothing would have triggered it? These are other questions that I'd pay good money to have answered.

When assessing significant deep-slab instabilities, I think that ski-area forecasters should assume that the public will find any spots on a given slope where it is possible for a skier to initiate a fracture. These spots frequently exist where the snowpack is thinner, and the weak layer is more accessible. The crux lies in being extremely confident that these nearly inevitable (in my opinion) fracture initiations will not propagate far enough to release the entire slope. If this premise is correct, then deploying several smaller explosive charges on the perimeter of a large suspect slab should be considered in addition to deploying larger shots in "more standard" locations.

In a nutshell, mix it up – hopefully one of the shots will be the right trigger in the right place at the right time. A simple concept, but we must remember that deep-slab forecasting and mitigation is neither simple nor an exact science. Following the close call at Big Sky, the ace deep-slab hunter mentioned earlier summed things up perfectly by stating, "I'll never control avalanches, but avalanches will always control me."

Scotty Savage is a frequent contributor to TAR as his knee heals from a series of surgeries.The author thanks Karl Birkeland, Mike Buotte, Liam Fitzgerald, Ron Simenhois, and Jon Ueland for valuable discussions and help editing this article.

Even if we have moved into a Low-danger period with buried weak layers, any time there is a change in the weather - a significant temperature increase, several inches of snow, wind transport - you have to look at it as if someone is poking at the troll under the bridge and aggravating him. Your actions and choices in the backcountry should reflect this philosophy. Janet Kellam

Thinking Back & Looking Forward

Story and photos by Craig Sterbenz

The winter of 2008/09 was a memorable one. Unfortunately, many of us would like to forget some of it. It was just a year ago that a rash of "in-area" avalanche accidents plagued the ski industry. What was different about last year that made it such a difficult winter? What can we learn from last winter's mishaps to help us make better decisions in the future?

Looking through the long list of accident reports, a few similarities pop up. Most of the cases were post-control avalanches that involved old-snow, deep-slab instabilities. Most occurred on the first day of opening the terrain or while conducting control operations in preparation of opening the terrain.

Thinking back, I can't say that we did anything wrong, and I doubt we'd do things much differently today. In the San Juans we are always plagued with deep-slab instabilities. It's a fact of life. However, dealing with these persistent deep-slab instabilities within a ski-area environment is certainly a conundrum.

There's this great story about the old postman who used to deliver the mail on horseback to the miners in Little Cottonwood Canyon long before Alta was a ski resort. When asked how he managed to avoid getting caught in avalanches, he replied, "It's simple, I always wait for a few days after the end of the storm."

Editor's note: For more on this story read Ed LaChapelle's essay, "The Ascending Spiral," which can be found in TAR 24-1 and 25-4.

I don't know if the story is true, but it's sage advice. Waiting until the old snow has absorbed and adjusted to the weight of the new snow is a prudent method of dealing with persistent deep-slab weakness. Depth hoar is strong in compression. A continental depth-hoar snowpack will stop settling when it has reached equilibrium with the weight of the snow it's supporting.


This photo shows the Dynamo which was boot packed in October '94. It snowed while we were in Snowbird at ISSW, and we didn't get back on it until after Thanksgiving. It was opened to the public in early December and skied daily. This slide happened on March 5 or 6 after a big storm. HS-AL-R5-O, 8' fracture. Ski packer tracks from October were visible on the bed surface; the weak layer was the ISSW94 storm.

Unfortunately, our culture is demanding. We are spoiled. We want it all, and we want it now. Waiting several days for things to "settle out" can be pretty tough in a ski-area environment. Bombing it into submission requires less patience. Unfortunately, we don't always get the results we're looking for. Maybe the timing is a little late. Maybe the shot is in the wrong spot, or maybe it's too small. Maybe there isn't enough weight. Maybe there isn't enough of a slab. Maybe some paths run and others that should don't…what now?


This release is from an avalauncher shot in March 1995; it was filmed by National Geographic – angry planet stuff – 225-year-old trees ripped out of the ground. HS-AL-R5-0, 22' at deepest point of fx. This terrain was not open to public then but is now; one of the "mishaps" from last year was a small pocket on a lower area of this ridge just off the right edge of this photo.

Mixed results and post-control releases are the worst. Today we had some paths pull out full depth to the ground with meter+ fractures. We had some paths that slid mid-pack and others that didn't move. We had widespread collapsing and cracking. We had one path that ran on approach, and we had post-control releases. The mountain manager called me to ask when we were going to get it open. I told him, "Not today and not tomorrow, but maybe the day after… we'll see how it goes tomorrow."

Post-control releases may in part be the result of one or two of the slab boundaries being fractured by the explosive charge while the remaining slab boundaries resist fracture and temporarily prevent avalanche release. If the remaining slab boundaries are subsequently fractured by a trigger, the slab will likely release. We'll go back out tomorrow and rework all the stuff that didn't move today. We'll see what we get for results, and then we'll wait. Waiting for 24 to 48 hours after the initial control work before opening the terrain will allow the fractured slab boundaries to "age harden," to heal from their wounds and regain strength, thus decreasing the likelihood of a post-control release.

Dealing with these deep-slab persistent instabilities is indeed a conundrum. There are no silver bullets. Work it and rework it until you are no longer getting collapsing, cracking, or avalanche release, then be patient and wait until it heals. When in doubt, wait. It's not wise to mess with Mother Nature and expect to get away with it 100% of the time.

Craig Sterbenz (Sterbie) has been an avalanche hunter in Telluride for a long time. He is still learning when to wait and when to work it.