THE Avalanche REVIEW

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National Avalanche Center
2002-03 Season Roundup

Compiled by Janet Kellam, July 2003

An avalanche triggered during backcountry explosive testing by a helicopter skiing company. Little Superior Buttress, Wasatch Range, Utah. Bruce Tremper photo (U.S. Forest Service Utah Avalanche Center)

In This Issue

The Forest Service National Avalanche Center had another successful year working toward our core mission, which is to support and provide program guidance to the regional avalanche centers, transfer technology to those centers and to the U.S. avalanche community, coordinate and manage the military artillery for avalanche mitigation program, provide expertise to Forest Service field units dealing with avalanche problems, and provide both Forest Service and public avalanche education. With just two employees – Doug Abromeit in Ketchum, Idaho and Karl Birkeland in Bozeman, Montana – to fulfill this mission, you can bet we stayed plenty busy!

The NAC started the year in our traditional way, hosting a meeting of all the U.S. avalanche center personnel. This year Doug hosted the meeting in Ketchum. In addition to a business meeting that helps all of the avalanche centers to maintain consistency, we also had a day of train-

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The American Avalanche Association

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Contributions: Please submit material eight weeks prior to publication date. Include address and telephone number. Please submit typed manuscripts by e-mail or disk (3.5", Zip or CD), using any popular word processing program. Submit any figures in B & W, or as a TIFF or EPS file (300 dpi resolution at 100%). We will return materials if you include a stamped, self-addressed envelope.

Articles, including editorials, appearing in The Avalanche Review reflect the individual views of the authors and not the official points of view adopted by AAA or the organizations with which the authors are affiliated unless otherwise stated.

FROM THE PRESIDENT: RUSS JOHNSON

By the time you read this summer will be a thing of the past. Ironically, summer seems to be the busiest time for the Governing Board as far as AAA work goes. We're mostly too busy in the winter to get a lot done. Furthermore, at the spring meeting we set goals for ourselves to take care of business in preparation for the fall general membership meeting.

This fall we planned an extravaganza for the fall membership meeting: a weather seminar and also an education seminar. Hopefully, as you read this *TAR* you are attending these events. If not, I'm sure a future *TAR* will cover them.

The research committee under Ethan Greene and Craig Sterbenz is currently tackling a U.S. version of the Canadian OGRES. The ultimate idea would be to have a North American standard for these guidelines. Whether this could ever come about we don't know, but in the meantime the Avalanche Association would like to produce an American standard to facilitate communication between professionals as well with the public.

Rockies Section Representative Woody Sherwood continues working on an explosives training curriculum and is currently in collusion with the NSAA and CAA to produce a PowerPoint presentation which explosive users could purchase. Based on a Canadian model, the presentation can easily be modified to suit individual users. With both the NSAA and AAA collaborating, this work should become the definitive training manual for explosives use in our industry.

Finally, we are initiating an internet store at *www.americanavalancheassociation.org* with AAA logo products. This is an effort to spread the name of the Association as well as to raise funds. We plan a modest start but hope the membership will access the store and think about purchasing Christmas gifts there as well.

As the new winter unfolds I want to thank you again for your support of the American Avalanche Association. It is the membership which keeps the association going and relevant. At the spring meeting we welcomed an additional thirty professional members which tells us we are on the right track in research, education and information.

Safe, fresh turns to all.
Russ Johnson

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METAMORPHISM

The Avalanche Review
A Call for Submissions

Seen any good avalanches lately?
Got some gossip for the other snow nerds out there?
Developing new tools or ideas?
Learn something from an accident investigation?
Tell us about a particularly tricky spot of terrain;
Send photos of a crown, of avalanche workers plowing roads, throwing bombs, teaching classes, or digging holes in the snow;
Pass on some industry news;

Write it up; send it to us. *The Avalanche Review* is only as good as the material you send.
TAR is accepting articles, stories, queries, papers, photos. We can help if you're not sure how to write it up.
Deadline for Vol. 22, Issue 2 is October 15, 2003
Deadline for Vol. 22, Issue 3 is January 15, 2004
Deadline for Vol. 22, Issue 4 is March 15, 2004
Send text as .doc or .rtf files. Send photos as black and white .jpg files.

Send materials to: ***The Avalanche Review***
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406/862-0812

Congratulations to these new AAA Certified Avalanche Instructors;
Tyson Bradley, Salt Lake City, UT
Rod Newcomb, Wilson, WY

AAA News

NOTICE OF ANNUAL MEETING, CONTINUING EDUCATION SEMINAR, AND FOR SOME OF YOU IT'S TIME TO RENEW YOUR MEMBERSHIP

Annual Meeting:

The AAA Annual Membership meeting will be held Friday, October 3, 2003, from 7pm to 9pm in the Magpie Room at the Cliff Lodge, Snowbird, Utah.

Continuing Education Seminar:

In conjunction with the annual meeting, AAA will sponsor a continuing education seminar on Saturday the 4th and Sunday the 5th in Ballroom 3 also at the Cliff Lodge in Snowbird. Saturday's theme is Avalanche Weather and Sunday's is Avalanche Education. AAA is lining up some great speakers and both of these days promise to be interesting and bring valuable avalanche information to you. The cost of these seminars is reasonable; $20 per day for Pros, Affiliates, Life, Honorary, Trade, and Comp members, $25 per day for Subscribers, and $50 per day for non-Members. Members must be in good standing with membership dues paid.

Lodging:

Snowbird is offering a very reasonable lodging package, $75 per night plus taxes for double rooms. Contact Snowbird Central Reservations by calling 1-800-453-3000 or by emailing to cres@snowbird.com **before September 7** to reserve rooms at this rate. Mention the avalanche seminar to receive the special rate. Snowbird has been very generous in hosting our seminar so please support them by staying at Snowbird. You are on your own for meals, but restaurants will be open at Snowbird. The seminar agenda will be finalized in the month or so. Look for updated information at the AAAwebsite: *http://www.avalanche.org/aaa.* Or feel free to contact me by phone or email.

At Snowbird the latest in AAA merchandise will also be available; hats, vests, fleece, and t-shirts.

Membership Renewal:

It is time for many, but not all of you, to renew your AAA Membership. A Membership Renewal Form is enclosed with this letter if this is the case. Your membership category, and renewal date are on the label of this correspondence if you are unsure of your status. If you have any questions about your renewal or status do not hesitate to contact me. In the past, many of you have included additional donations to AAA. Donations can be made to the General Operating Fund or to the Educational Endowment Fund. Donations further the AAA mission and sponsor pertinent avalanche research and education opportunities.

Several reminders for successful renewals:

1) Payment must be made in US dollars.
2) If your company is paying for your memberships, make sure payment indicates for whom the payment is intended.

Your prompt attention to renewing your membership is always appreciated.

AAA values your membership and support. Let us know how AAAcan serve you better. Contact me by mail, phone, or email with your suggestions. Thank you in advance for your continued support of AAA. Best wishes and I hope to see you in Snowbird.

Mark Mueller, Executive Director

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WHAT'S NEW

BCA Introduces
Naxo Binding

Backcountry Access (BCA) has announced today that it is marketing and distributing the revolutionary new Naxo alpine touring (AT) binding in North America, effective immediately.

The Naxo nx01 is a super high-performance AT binding from Switzerland with a full alpine toepiece, maximum DIN setting of 12, and an innovative "virtual rotation system" that increases stride ergonomics while touring. It was developed by Naxo AG of Thun, Switzerland, a company founded in 2001 by former managers at alpine touring manufacturer, Fritschi AG. Naxo was introduced to the European market during the 2002-03 season.

The crux of the Naxo design is its beefy toepiece and virtual rotation system. By providing two pivot points – one beneath and one in front of the toepiece, the system allows for a full-sized alpine-style toe conforming to DIN standards for both alpine/downhill and alpine touring boots. It also creates a more rounded gait, reducing the "Frankenstein" stride often experienced with existing AT bindings, according to McGowan. In addition, the heel piece locks down in such a way that it cannot prerelease due to flexion of the ski. Binding length and spring tension at the toe and heel can be adjusted quickly by hand, making it ideal for rental use.

BCA began taking orders from North American retailers on June 5 for delivery in autumn 2003. The U.S. suggested retail price for the nx01 is $299.95, including ski brakes. The professional price is $180.

For more information, contact Bruce Edgerly at edge@bcaccess.com or (303)417-1345.

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ISSW 2004
September l9-24
Jackson Hole, Wyoming, Walk Festival Hall.

Mark the dates and reserve your space now.

Tuition - $l90 until Mar l, 2004
Tuition - $2l5 until Aug 3l, 2004
Tuition - $235 after Aug 3l, 2004

Registration and Information will be available October l, 2003 at ***www.issw.net***.

Field session on Teton Pass and Jackson Hole Mountain Resort is planned for Wednesday, September 22.

Criteria for submission of presentations and posters will be posted on the web site.

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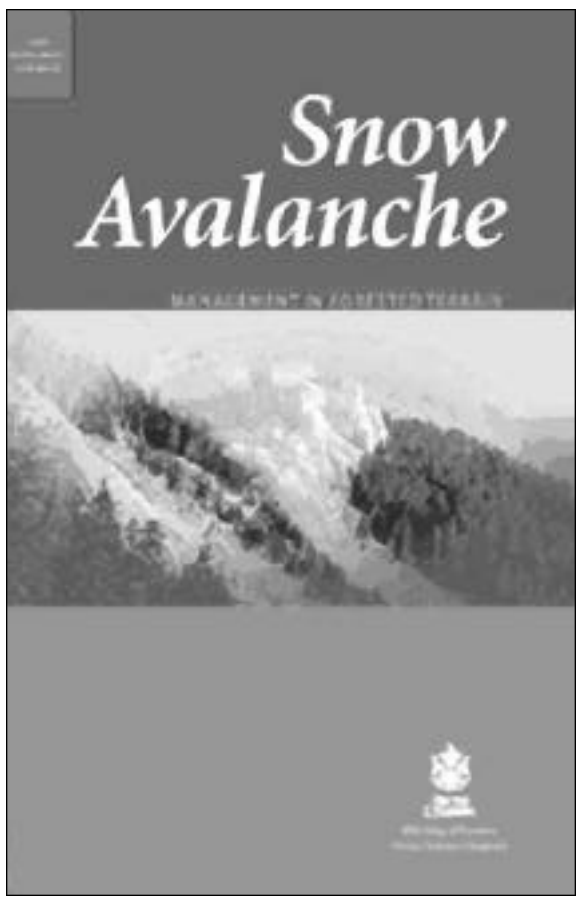
Forestry Avalanche Handbook Available On-Line

Peter Weir's handbook, *Snow Avalanche Management in Forested Terrain*, is now available on the web as a .PDF file. Weir prepared the book, which addresses snow and avalanche phenomena in a forestry setting, for the BC Ministry of Forests. The handbook outlines harvest design and silvicultural strategies to reduce the risk of avalanche damage resulting from forest harvesting. Weir also presents strategies for managing avalanche risks, and includes an extensive bibliography. The .PDF file is free and available at: http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh55.htm.



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Ortovox Announces F1 Heli

Ortovox has modified its classic F1 avalanche transceiver to give heli pilots an even more valuable role in search and rescue operations. The Heli F1 is modified to only receive signals and be installed in reach of the pilot so he or she can handle the volume control switch while flying. Ortovox removed the steel antennae from the beacon and situated it in a tube mounted outside of the helicopter or attached to the helicopter skid for maximum range. Ortovox's analog technology gives the Heli F1 a range of over 80 meters and the ability to isolate signals with the volume control switch, when searching for multiple victims.

"Through our work with rescue, guide and patrol professionals worldwide, we created a reasonably priced product specifically for the growing helicopter market," says Marcus Peterson, General Manager of Ortovox USA. "Ortovox created the Heli F1 as another level of our commitment to increasing the number of rescues and decreasing the critical time factor."

Like all Ortovox avalanche transceivers, the helicopter system has a plug socket for connecting an earphone. The signal can be fed into the radio equipment, allowing the pilot to directly approach the victim. The rescue team can then be dropped off at the point where the pilot received the strongest signal to start a pinpoint search and rescue of the buried person. The searchers need to be carrying their own avalanche transceivers, probe poles and shovels.

The Federal Border Guard of Germany and other European guide services tested the Heli F1 last winter during rescues and training; it proved itself easy to use and time saving. Winter 2003-2004 will mark the F1 Heli's trip across the pond as it is added to safety efforts of guide operations across North America including Ruby Mountain Heli Ski and High Mountain Heli. Testing and training begins this fall.

For additional information, visit the Ortovox website at www.ortovox.com.

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MEDIA

Surviving Digital Photography

By Bruce Tremper

Editor's note: This is the first of a two part series by Bruce Tremper on Digital Photography. Next issue's installment will cover managing and editing digital images on the computer.

It's no use. We can't hold back the deluge any longer. Film is officially dead. Many of the old time photographers like me had to be drug, kicking and screaming, into the scary world of digital photography. Like many others, I waited patiently until the technology finally came of age. But a couple years ago, we finally decided that it was time we dove on into the big pond. We bought digital cameras for everyone on our staff and since I started shooting digital, I—like almost everyone else who have spent more than a few minutes with a digital camera—have hardly touched my film camera since. I'm hooked for good.

The bad news is that big, paradigm-shifting change like film to digital involves some pain, especially for the technophobic, a category into which most avalanche people happily relegate themselves. The good news is that once you've made the switch, it often ranks somewhere on the level of a religious epiphany. You can spot the other converts at parties, off in the corner talking with wild-eyed glee to other born-again brethren about the evils of film and the innumerable saintly qualities of digital. They will speak in tongues—about "transform tools, layer masks, luminosity channels, monitor calibrations, compression schemes and magnetic lassos." And like the computer nerds of 20 years ago, yes, they're boring at parties but they live at the cutting edge of a brand new world. Sadly, I am now one of them. Make no mistake, once you switch, once you bite the bullet and dive on in face first, you will absolutely never go back. Digital is good—very, very good.

Here is a very abbreviated primer on what everyone needs to know about the brave new world of digital photography.

Advantages of digital photography

Ah, let me count the ways…

Small, compact cameras.

You can look at your photo right after you take it—instant feedback.

You can experiment like crazy because it costs nothing except your time.

You can post the photo on the Internet or e-mail it to someone right after you take it.

Digital has much wider exposure latitude than film (you can see shadows and highlights better, which means that it is far superior for shooting in the high contrast world of outdoor photography, especially on snow).

Digital has better color and you can easily manipulate the color afterwards.

It is much easier to organize and store images and add captions to digital images.

When giving presentations, digital images are far easier and faster to organize into a slide show. Plus, you can use a digital projector, which is brighter than the old Kodak carousel. Now, you don't even have to dim the lights in the room.

It is much easier and cheaper to print digital images — you can print it yourself.

You can easily stitch photos together to make very high resolution panoramas or composite images composed of many different smaller images that you can blow up to the size of a wall. No more heavy and cumbersome, large or medium format cameras. You can even control perspective, like a large format camera. You do it on the computer.

You can easily attach digital images to a database of avalanche occurrence.

You can submit them to 20 different magazines for publication at the same time without spending a fortune on film dupes—yippee!

Disadvantages of digital photography

Hmmm. Let me think….

OK, maybe one:

Digital projectors are more expensive, but they are coming down in price fast.

The technology is daunting at first but it's astoundingly addictive once you get the hang of it.

The Basics of Digital Photography:

We might as well get it over with right away. At some point, everyone needs to dive on in and learn the basics of pixels, resolution, file types and other geek stuff. Unfortunately, there's no way around it, so grab a cup of tea and laser on in for a few minutes.

Digital cameras store their information in "pixels," i.e. tiny specks of digital data that magically appear on your computer screen or on a printer. Pixels amassed together make an image; on most computer screens, there are 1024 of them lined across the screen and 760 of them lined up vertically making a total of 778,240 pixels. In other words, a computer screen displays nearly one "megapixel" (one million pixels) the now-familiar term you read in most advertisements for digital cameras. The more pixels you can build into a camera, on a computer screen or onto a printer, the sharper the image (higher resolution). Cheap cameras have one or two mega pixels and expensive cameras have 5 or 6 megapixels—which cost somewhere around $200 per megapixel. And instead of being stored on film, all these pixels are stored on tiny little flash cards, which, of course, rise in price with the amount of data you can store on each card.

The trouble with expensive cameras are that, yes, they take high resolution photos but they also generate huge, cumbersome files, which require large flash cards and large hard drives on your computer to store them. Most avalanche folks will use digital photos for relatively low-tech things, like teaching avalanche classes, posting images on the web, e-mailing images to someone, putting images into a database program to keep track of avalanches, or printing up an 8 x 10 photo to hang on the wall. For any of these purposes, the good news is that you won't need a very expensive camera. A 2 megapixel camera with a 128 megabyte flash card will be plenty. In fact, most of the time, my trusty lightweight 2 megapixel camera images need to be chopped down to a smaller size if I'm doing anything except printing.

Next, here are some other concepts we need to know:

Resolution simply means the number of pixels per inch on the computer screen or the number of dots per inch on a printed page. For instance, computer screens use 72 pixels per inch and most printers need 300 dots per inch. In other words, you need a much larger file size if you want to print something than if you just want to display it on the computer screen. It takes some time to grasp all this so spend some time studying the little table below.

The high contrast world of snow where digital photography excels. A slide in Little Water Gulch, Wasatch Range, Utah, January 5, 2003. Bruce Tremper photo (U.S. Forest Service Utah Avalanche Center).

File types:

JPEG files: Most of the cheaper cameras can only store the files as "JPEG" files, while the more expensive cameras can also store them as either TIFF files or as RAW files. Here's the difference: JPEG (or also JPG) is a file compression scheme which takes repetitive portions of your photograph—say, a patch of blue sky—and compresses all those identical pixels into a single piece of information. This way, the file takes up less room on your computer or memory chip. When the image is viewed on the computer, it expands the image to its original size. The trouble with JPEG is that each time you open the file, edit the image and store the file again, you lose some information and your image looks worse every time you re-save the file.

Most image editing programs let you choose how much compression you want in your saved file. If you choose a high quality (12) it won't compress the image very much, you lose very little quality, but you end up with a large file size. If you choose a low number (3), you get a small file size, but the image starts looking fuzzy and ragged. As with most things in life, there's a trade off. If you're posting the photo to the Internet or e-mailing it, you are much more concerned with image size than image quality, so you can choose a low quality when you save the file. If you want to print the image or save it for archive on a CD or hard drive, then save it with a high quality setting. Most people will probably want to shoot all their photos as JPEG files unless you plan on making large

Printed size (at 300 dpi)	Pixel dimensions	Resolution in pixels per inch	Saved as JPEG quality	Compressed File Size	Download Time with a 56 k modem	Works best for:
8 x 10 inches	3000 x 2500	300	12 very high	3.3 mb	10 minutes	Printing 8 x 10 prints
5 x 7 inches	2100 x 1500	300	12 very high	2.2 mb	7 minutes	Printing 5 x 7 prints
6.8 x 4.5 inches	1050 x 750	150	12 very high	656 kb	2 minutes	Printing on lower resolution printers
3.4 x 2.2 inches	1024 x 760	72	10 med-high	370 kb	66 seconds	PowerPoint presentations
1 x 1.6 inches	504 x 360	72	6 medium	50 kb	9 seconds	E-mail or web site

The above table of JPEG images shows that if you want to e-mail the photo or post it on the web, you need to save it as a small file, that is, no more than 600 x 800 pixels at a resolution of 72 and compress the photo quite a bit. (Most e-mail servers don't allow file attachments over 1 megabyte) In other words, you should save it with the settings like the one at the bottom of the table. On the other hand, if you're going to send the photo for publication in a magazine or print it, then you should save it as the largest size possible and either save it as the highest quality JPEG file (12) or save it as a TIFF file. But remember, these files will be too large to e-mail or post on the web.

prints or you want to sell images to magazines, in which case, you should shoot, edit and store the image in one of the next two file types.

TIFF files. This is a file in which every single piece of information your camera recorded for each pixel is saved in the file. This makes for high quality images but huge files. The advantage of TIFF files is that you can open them up, edit them, and re-save them as many times as you want and you suffer no image loss. So if you want a high quality image for printing or to send to a magazine, or if you plan on editing the photo several times on your computer, then you should save it as a TIFF or RAW file (see below). But remember, these files are so large that they will quickly fill up your hard drive and they take a long time to load into any program.

RAW files: For the true geeks, RAW files contain the maximum amount of information possible and the file size is correspondingly huge. Shoot in RAW only if you are a Photoshop expert and plan to make very large prints of your photos and, and/or want to sell your images to magazines. For instance, for serious work, I usually shoot and edit in RAW mode, then store them as a Photoshop file after I'm done editing. Then I make a duplicate copy in JPEG in the appropriate size so I can e-mail it, post it on the web or use it in a Powerpoint presentation.

Making the most of digital photography's wide exposure latitude: avalanche on Little Superior Butress in Cardiff Fork, Wasatch Range, Utah. Photo by Bruce Tremper

The tricks of the trade applied: this thick layer of faceted snow provided a very active layer for both natural and human triggered avalanches throughout the 2002-03 winter. Bruce Tremper photo (U.S. Forest Service Utah Avalanche Center).

Digital Tricks for Taking Photos of Snow

Modern digital cameras do a great job of making even idiot photographers look like pros. But, unfortunately, photography on snow always has been and probably always will be one of the most difficult situations to photograph whether you're using film or digital. Fortunately, it's a little easier with digital.

Problem 1 – too much light

First, on a very bright, sunny day, there's so much light that sometimes your digital images will look washed out and overexposed. Many cameras have a setting for snow or a white beach, which simply lowers the ISO setting on the camera to 50 from the usual 100. If it doesn't have a snow setting, and it lets you adjust the ISO setting manually, set it to 50 or less. The first rule of digital photography is to never overexpose (washed-out photos). You can get away with underexposing a photo but never overexposing. Read up on the camera's histogram feature, if it has one, and try to keep the graph looking like a nice bell-shaped curve, without it bunching up against one side of the graph.

Problem 2 – the dreaded blue snow

Blue snow is a big problem with both film and digital cameras and is probably the most vexing problem for people who shoot on snow. Why? On a clear, sunny day any snow in the shadow will reflect the color of the sky. Now, comes the tricky part. Your brain compensates for this and even though the snow looks perfectly white to you, the snow really IS blue and that's exactly what the camera records. It's maddening. With film, the only solution is to use a warming filter in combination with a film with a warm colorcast. Blue snow is also a problem when you scan slides using an automated setting. The slide looks great, but the scan turns the snow blue.

With digital cameras, technology comes to the rescue. You can manually adjust what is called the "white balance." You will probably have to read up on this feature in the manual. Usually you have to go into the camera menu and set the camera to do a manual white balance. Then point the camera at the snow you want to look white and push the white balance button. Then, the following photos will make the snow white instead of blue. Remember to reset the white balance when you go back into the sun (usually turning the camera off then on again resets the white balance). If you forgot to white balance or you have lots of old, blue photos you need to correct, I have some techniques in the second installment of this article on how to fix blue snow on the computer with image editing programs.

Here's another trick. Instead of filling the entire frame with snow, try to include some other colors in the photo, for instance, include some trees, rocks or a person examining the fracture line profile in the foreground. This way, the camera sees other colors than the blue snow and the automatic white balance on the camera will know to make the snow white instead of blue, in which case there's no need to do a manual white balance.

Organization on the Computer

In order to transfer photos onto the computer, most cameras plug into the computer with a USB cable and you use the software that came with the camera. Instead, I like using an external memory card reader, which you can buy in the store for about $25. Simply take your memory card out of the camera and plug it into the card reader and the computer treats it just like another drive on your computer. And the coolest feature of card readers is that you can use them like a floppy disk or zip disk, to transfer large files between computers. I'm always carrying around a bunch of files on my memory card that I'm transferring between the various computers I work on. I just carry the little card reader with me wherever I go and plug it into the USB port on the computer. It's the modern version of the floppy disk, but vastly larger.

Bruce Tremper is the Director of the Forest Service Utah Avalanche Center and made a living as a photographer before he caught the avalanche bug 25 years ago. He spends his summers as a photographer and writer. Bruce recently won the prestigious Nature's Best Magazine photography competition for the People in Nature category. His image is on display in the Smithsonian Museum of Natural History in Washington D.C. His photographs appear frequently in The Avalanche Review*, including this issue's cover story.*

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CROWN PROFILES

A Brief Look at Avalanche Activities in France, or Our Own Private Snow Science Workshop

By Mark Mueller and Sandra Kobrock

Last spring we had a great opportunity to visit the French Alps and meet some colleagues there. Our visit was organized by Francois Sivardiere, the Director of ANENA (Association Nationale pour l'Etude de la Neige et des Avalanches), the French national association for the study of snow and avalanches. Francois spent December of 2002 visiting Colorado and taking in some of the avalanche scene here. During his visit we mentioned we were planning a vacation to France in May after our avalanche season ended. He enthusiastically invited us to spend some time with him and offered to connect us with some French avalanche workers and researchers. Our trip to the Alps was planned more as a vacation than work, and Francois made sure we had ample opportunities to ski some classic descents in the western Alps as well as indulge and enjoy the local wine, cheese, and other regional specialties.

ANENA was founded in 1971 after an avalanche the previous winter struck lodges in the resort of Val d'Isere leaving 39 young people dead. ANENA was created to coordinate the disparate activities of private and governmental groups and individuals involved in avalanche safety and research. That mission has evolved over the years with ANENA now taking its own place, primarily providing avalanche safety information and training. ANENA has over 1000 members. Unlike AAA, there is only one membership category, and all members are eligible to vote for the Board of Directors. ANENA maintains a permanent office in Grenoble with a staff of 7. Of the 7, only Francois and one other are avalanche professionals. Other staff include a receptionist, web mistress, librarian, accountant, secretary, and the designer for ANENA's journal, "Neige et Avalanches," which ANENA publishes quarterly. Last fall marked its 100th issue. A very important function that ANENA provides is the comprehensive and specific training and certification for French avalanche workers in the use of explosives. They also provide certification for avalanche rescue dog handlers. ANENA has also made available an extensive array of avalanche literature and training materials. Their catalog can be found at their website, www.anena.org.

Francois arranged for us to meet avalanche practitioners and researchers involved in a variety of snow and avalanche activities. At each opportunity these people greeted us with enthusiasm and friendship. All were anxious to show us the work that they have been doing, from private and government researchers, to ski resort and highway safety managers. Their work included snowpack modeling, avalanche sensing by means of radar, measurement of blowing snow (an elusive but important component of avalanche forecasting models), and measurement of blowing snow in a lab wind tunnel and in the field. We were shown impressive data collection and management tools, avalanche mapping tools, and avalanche flow models. Much of this work has been described during the last several International Snow Science Workshops. Our personal tour was like our own private ISSW. We often felt obliged to apologize for our lack of academic backgrounds, but our hosts felt this unnecessary and were more than happy to not only speak English, but to make sure we understood their work. We also had the opportunity to answer their questions about avalanche work and research in the United States.

The two research facilities we visited were located on the sprawling grounds of the University of Grenoble. At CEMAGREF, the snow avalanche engineering and torrent control research unit, the research we saw was concentrated on blowing snow and avalanche dynamics. In addition, a nation-wide avalanche mapping project is an ongoing project at CEMAGREF. At Meteo France, the French weather service that also has responsibility for regional avalanche forecasting, we visited CEN (Centre d' Etudes de la Neige), the Snow Study Center, part of the Meteo France's National Center for Meteorological Research. The work we saw there centered on snowpack modeling for avalanche forecasting. We also were impressed by their weather, snowpack, and avalanche data collection system.

On several field trips (Grenoble is centrally situated within two hours of most mountain locations) we visited Tignes ski area and a highway avalanche control project at Bonneval sur Arc. We also found our own way to the CEMAGREF's avalanche field laboratory above the Col du Lauteret (the Tour de France bike race regularly passes right by this site). Here Gazex and Avalhex are used to trigger avalanches, with instrument masts for measuring avalanche characteristics, and an instrument shelter built into the side of the road.

This Avalex gas exploder is part of the CEMAGREF snow study area above the Col du Lauteret. Photo by Mark Muller.

During our visit, the field laboratory was the site of a half-day roundtable on a topical issue where we could offer a US perspective: should backcountry or off-piste skiing and boarding be more restricted? We chose not to attend because it was in French and we were, after all, on vacation. Francois later gave us a summary: many mistakenly believed that all U.S. ski area boundaries were closed (of course until recently this was by and large true). Some people approved of this practice and perhaps hoped to implement it to some degree at their areas. With the enormous scale of the Alpine "backcountry" and the increasing popularity of the more extreme practices, professional safety rescue personnel are feeling increased pressure while marketing departments and tourist bureaus extol the wonders of their off-piste terrain. The issue is far from settled. The meeting was hosted by Robert Bolognesi of Meteorisk, a private consulting firm.

We are always impressed by the Alps: their massive summits, widespread avalanche works, and the numerous monuments to individuals and villages struck by avalanches. Combined with the beautiful Alpine villages, the endless ski descents, and the friendly people, a keen avalanche enthusiast feels right at home.

We would especially like to thank our host Francois Sivardiere, as well as Robert Bolognesi, Eric Van Lancker, Vincent Chritin, Alain Duclos (TRANSMONTAGNE), Eric Martin (CEN), Yves Durand (CEN), Jean-Louis Tuaillon (Director Securite de Pistes Tignes), and Mohamed Naaim, Florence Naaim, Michel Gay, and Vincent Bain (all at CEMAGREF). We will never forget your warmth and hospitality.

Catex and revegetation work at Alpe d' Huez. Photo by Mark Muller.

An avalanche alarm on French National Highway 91 between Alpe d'Huezand La Grave. A steep canyon with amazing waterfalls. Photo by Mark Muller

The CEMAGREF study site at Lauteret. Slides are triggered by Gazex or Avalex. Instrumentation can be attached to masts which run down the slope for several hundred meters. The instrument shelter is right on the roadway, chiseled into the bank. Photo by Mark Muller

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Montroc, on the Road to Perdition

By David B. George

On the 9th of February 1999 the village of Montroc near Chamonix in France was hit by a massive avalanche killing 12 people in their homes. Was this a freak event in an unusu - al winter or something the authorities could have seen coming?

I turned off the autoroute at Martigny and under grey skies began the climb over the road pass to Chamonix. It was just a week after the massive avalanche that had hit Montroc. The low cloud, turning to mist, obscured the valley. Then, rounding a bend, I was greeted by a scene of such utter devastation it was breathtaking. Forest, buildings, pylons — all smashed and broken almost beyond human recognition.

A few days later, the journalist Jacqueline Meillon, in an article published in *Le Parisien*, raised doubts over the planning procedures followed in the Chamonix valley. It appeared that in an effort to balance development pressures in the densely populated French Alps against the risks some dangers had been overlooked. This article pieces together the chain of events that lead to the Montroc disaster.

The winter had started well with enough snowfall for many ski resorts to open early. A period of cold dry weather followed. Ideal conditions for the formation of hoar crystals and a fragile base for future snowfall. After a dry spell the snow finally arrived on the 26th of January. Well over a meter fell at la Tour, but nothing too alarming. The weather turned cold and dry again. Then the big one: on the 7th of February a deep depression crossed France. Over three days it dumped more than two meters of snow on Chamonix. In the high winds, snow accumulated to worrying depths above the town. The avalanche risk was at its maximum. In the town hall the experts of the Avalanche Consultative Committee met to discuss the growing crisis. Evacuate? But where? There were over 100 known avalanche paths in the valley. Years of development under pressure from the tourist industry meant that nearly every community had some chalets at risk.

Far above the hamlet of le Poses snow had been piling up in a bowl. The valley culminated at 2450 metres at a point called la Montagne de Péclerey. At around 2:40pm on the 9th of February, while the committee discussed the situation, a slab of snow some 1.5 meters deep and over an area of 30 hectares broke away. This mass of snow started to accelerate down the 35 degree slope. At 1950 meters the slope levelled out; most winters this was enough to stop a slide in its tracks. But this avalanche was bigger, bigger than Montroc had seen for over 40 years. The slide shot past the plateau and picked up the snow accumulated on the other side. 300,000 cubic meters of snow were now channelled directly onto the hamlet below. Nothing could resist these massive forces of nature. Travelling at 60 mph with a pressure of 5 tonnes per m^2, chalets were pulverised and the debris carried over 100 meters. When the slide came to rest, 14 buildings had been totally destroyed and 6 badly damaged. The remains, and any people inside, were buried under 100,000 tonnes of snow to a depth of 5 meters. It was as if a bomb had been dropped on the whole area.

Figure 1: Clearing the Debris

Four years later and that bombshell is still reverberating. Michel Charlet, the Mayor of Chamonix, has been found guilty of second-degree murder for not having evacuated the chalets in the 48 hours prior to the avalanche. Charlet received a 3 months suspended sentence despite a call on the opening day of the trial by the state prosecutor for the charges to be dropped on the grounds that the avalanche zoning plans were incorrect. The court stated that the Mayor is the only person responsible for evacuating houses at serious risk.

A representative for the families of the non-Chamonix victims said the verdict would remind Mayors "*that they have priorities other than organising festivals, flowers and majorettes. Things have to change so that our children didn't die in vain…*"

Before the trial Mr. Charlet made these comments on the charges, "*Avalanche maps existed, they were wrong, since the avalanche happened at a place supposedly without risk, and I was supposed to interpret that even if there was no risk an avalanche could still happen?*"

Mr. Charlet has decided not to appeal to permit families of the victims to receive compensation, but it also means that the judgement will become part of French case law.

One of the jobs of avalanche researchers is to predict where and how often avalanches will occur. Despite sophisticated computer models and much investigation the actual mechanics of snow within a moving avalanche is still not that well understood. It is therefore important to correlate the predictions that computers provide with actual statistics from the area being studied. This lack of confidence in software means that local knowledge is still the basic tool of avalanche prediction.

Statistical modelling of the avalanche site by the French Avalanche Research Centre (ANENA) showed that the Montroc avalanche was between a 150 and 300 year event. Return periods of more than 100 years are not normally used when evaluating planning risks (Plan de Prévention des Risques Naturels - PPR) by the French authorities. Switzerland, with a longer tradition of avalanche risk assessment, uses 300 year events. North America, with a much greater reliance on statistical analysis, often uses even longer return periods. It should be remembered that a 150 year event does not mean that an avalanche of that magnitude will occur only once every 150 years but that there is a 1/150 chance that such an event will occur in any year. For longer periods the following formula can be used:

Probability % = $1 - (1/T)^L$

Where T is the return period and L is the number of years. So for a thirty year period there is an 18% chance of seeing a 150 year avalanche.

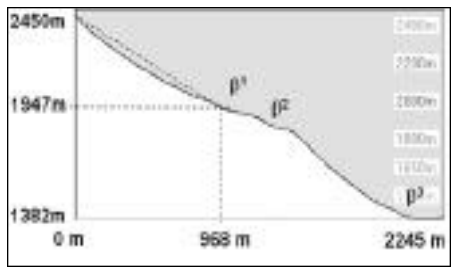

Figure 2: Slope Profile

The avalanche path at Montroc consists of two convex slopes. The table below gives the points where the slope angle falls to 10°, the so-called *beta points.* The Péclerey avalanche normally occurs as two separate slides; one starting at 2450 meters and stopping somewhere beyond ?[1], the second beta point can be ignored for runout calculations. It is possible for a second avalanche to start at 1700 meters.

At the end of the run the slope curves slightly upwards from the bed of the Arve river towards the road and the point where the chalets were located. Although this upslope would appear to offer some protection, it must be remembered that during the winter such relief would be smoothed by snowfall, especially during the exceptional conditions of February 1999. More surprisingly, the average angle from the road to the starting zone (the alpha angle) is over 25 degrees. In British Columbia this would restrict the site to lower risk highway use rather than permanent construction.

Continues on next page

Point	Fall (m)	Run (m)	Angle°
$\_^1$	503	968	27.4
$\_^2$	589	1245	25.3
$\_^3$	1062	2062	27.2
α	1060	2245	25.3

Table 1: **Angles to Starting Point**

In Europe, with its long history of habitation in the mountains, local knowledge is particularly reliable. In the first century AD, the Roman poet Silius Italicus tells us that Hannibal's army were caught by a snowstorm, perhaps high on the Col du Mont Genèvre near Briançon. On the steep descent the troops were hit by avalanches. In total Hannibal lost 18,000 men and 2,000 horses crossing the Alps. Avalanche deaths became more frequent as people started to build villages higher in the mountains. The Rodi avalanche in Switzerland in 1618 killed over 2,000 people. The 1720 Galen avalanche claimed 88 lives. Although the causes of avalanches were not well understood, in 1723 the Swiss writer Johann Scheuchzer attributed them to dragons; locals were still able to observe where avalanches happened and avoid building in those spots. Avalanches were named according to the slope or valley where they occurred. Over the centuries the safe terrain was gradually exploited and other areas left for agricultural use.

The locals at Montroc knew that the part of the valley called The Poses was prone to avalanches. Five times over the previous century an avalanche had torn down from Mount Péclerey. In 1843 and then in 1945 it had covered an area as far as the road to the village of Le Tour. The fact that it didn't come often made it no less feared. During periods of high avalanche risk locals would warn visitors not to go past Le Tomka, a chalet on the road to Le Tour.

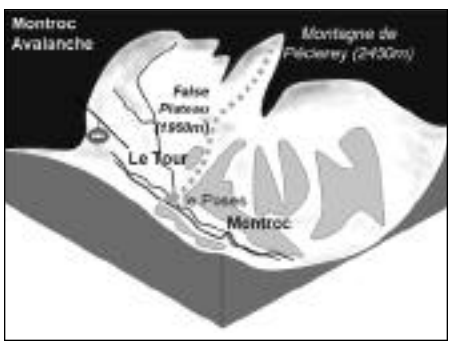

Figure 3: **The Avalanche Path**

As the cradle of alpinism, Chamonix has been a pioneer in French efforts avalanche prediction. In 1945, the town had an avalanche map, the first of its kind in France. It describes the two avalanches at le Poses that meet on the Le Tour road, corresponding to the local knowledge at that time.

Crossing the Rubicon

If we want to look for a single cause for the Montroc tragedy, a smoking gun, we have to return to 1970. Chamonix was growing fast under pressure from 'White Gold', the money from winter sports tourism as the locals called it. Maurice Herzog, then the deputy mayor, was put in charge of drawing up an urban development plan (*Plan d'Urbanism* or PUD). Herzog was a mountaineer of some reputation; he and Louis Lachenal had been the first men to stand on the summit of an 8000-metre peak. On his return to France he had exploited this success for commercial and political purposes, something that did not sit easily with some members of the mountaineering fraternity. Montroc was one of the sites zoned for development. The '71 PUD noted the two avalanches known by the locals.

That same year a huge avalanche hit Val d'Isère killing 39 people. Val d'Isère along with other resorts in France had been growing at an almost uncontrolled rate as part of the French state's plan to develop winter tourism. Buildings were constructed without receiving planning permission and, it was alleged, without proper studies of the known risks. The Val d'Isère accident was followed by deaths at Tignes and then finally at the end of the season a hospital near Chamonix was hit by a mud and snow slide claiming 72 victims, of which 56 were children.

The bad publicity generated by these deaths made it nearly impossible for promoters to sell apartments in the ski stations. The development of the new resort of Val Thorens had to be put on hold. To calm public anxiety the government launched a vast project to localise the areas at risk. These maps were called *Cartes de localisation probable des Avalanches* or CLPA. Naturally Chamonix was chosen as a pilot project. However the CLPA for Montroc didn't record either the 1843 and 1945 avalanches. The Poses was only marked as a possible avalanche zone. The zone stopped a long way from the road and the Péclerey avalanche was shown starting lower down at 1700 and not 2450 meters. This CLPA would be the basis for subsequent zoning documents.

In light of the new CLPA, Maurice Herzog decided to revise the PUD. From February 1973 a series of meetings worked on a new document. Finally the public was invited to comment. Armand Charlet, a teacher at the French Ski School (ENSA) and a respected guide, was strongly critical of the plan and noted that no account had been taken of "*the avalanches of Grand Lanchy (Péclerey) and opposite that of d'Amont Vargnoz which covered the area as far as the Le Tour road on the 12th February 1945*", he regretted that he had not been invited to the earlier meetings. "*Fortunately not!*" an unknown author commented in the margin, "*or there wouldn't be a single plot of land worthy of construction*". On the 13th of June 1973 the Town Council voted to adopt the new plan, the "*importance of which cannot be exaggerated*" commented Herzog, somewhat prophetically. The guide's warnings had been ignored.

This document, along with the Avalanche Zoning Plan (Plan de Zonage d'Exposition aux Avalanche - PZEA) prepared by the State Authorities formed the basis for the area development plan (Plan d'Occupation des Sols - POS). The POS was finally approved in 1979 and specified three zones:

white: no risk of avalanche

blue: the risk exists and for new buildings there are certain regulations involving materials and design

red: high risk, no new construction allowed

The Poses lay largely in a white zone, so the land formerly reserved for agricultural use could now be sold for development at a much more interesting price, of course.

A year earlier, on the 2nd of February 1978 in what was practically a rehearsal for the events at Montroc, an avalanche in the Couloir de Nantet crossed the river Arve and hit four chalets at Le Tour, killing five people. A court heard that although the area was zoned for construction, a similar avalanche had occurred in 1966 and that the builder and town planners should have been aware of the risks.

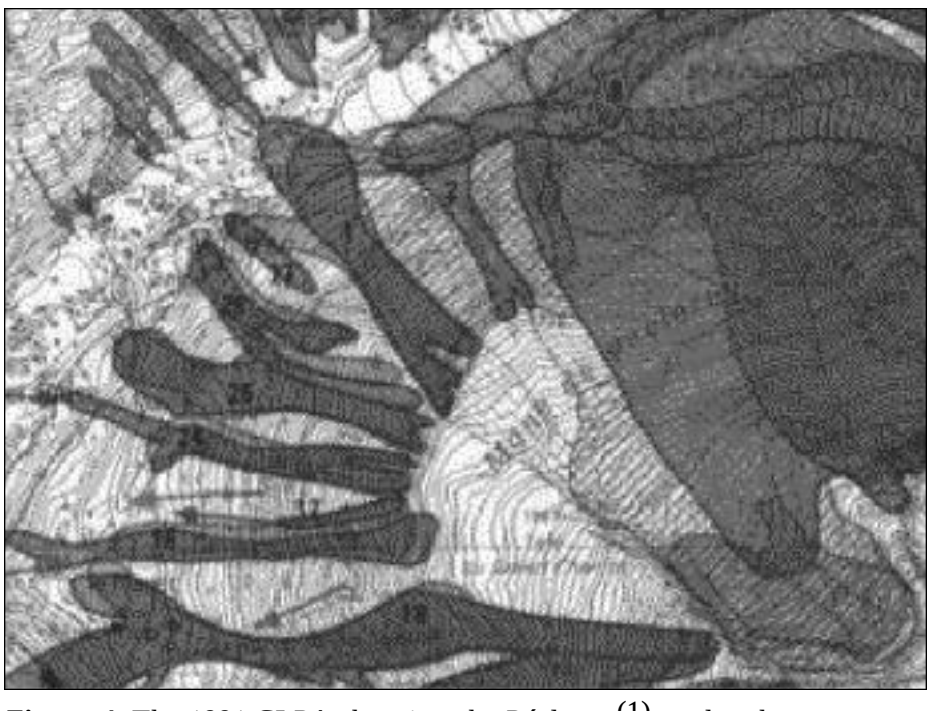

Figure 4: The 1991 CLPA showing the Péclerey(1) avalanche

In 1991 Cemagref revised the CLPA. This time the track taken by the Péclerey was marked as crossing the Le Tour road, as it had in the 1945 plan. The area covered on the map was almost identical to that of the 1999 accident. But neither the POS or even the Risk Evaluation Plan (PER) adopted the following year were revised.

Eleven of the chalets destroyed in the avalanche at Montroc were built in a white zone, a sector classed as having zero risk of avalanche, but was in fact known to be threatened by two avalanches. Amongst the victims were four children and a family of five from the Jura. But was building in the path of two avalanches conspiracy or cock-up?

A key actor in the drama was the agent, now dead, who prepared the 1971 avalanche plan (CLPA). Working alone, little is known about how he went about this task, whether he consulted the locals or looked at the 1945 plan. He had aerial photographs of the site, but these were unlikely to show traces of such a rare event. The subsequent town planning documents, agreed to by the council, took full advantage of his revisions. However, even the '71 CLPA notes the possibility of an avalanche starting from Mont Péclerey and covering the area to the road. The mayor of Chamonix, Michel Charlet, states that unlike the incidents of 1970 there was no irregularity in any planning permission granted and that all the available documents (CLPA, POS, PZEA, PPR etc) were validated at a number of levels. He goes on to warn against viewing certain documents with the benefit of hindsight and notes that Armand Charlet's comments were recorded by the CLPA but they were never communicated to subsequent Mayors.

It is possible that the councillors who approved the town plan and the locals who condoned it truly believed that big avalanches could be channelled and controlled and were a thing of the past, although the tragic events of 1970 and 1978 should have been a warning against hubris. The wall of silence that reigns in the valley means that it is difficult to shed more light on this point. Danielle Arnaud's book, *La Neige Empoisonnée* (Poisoned Snow) talks of the strong local pressure put on officials mapping avalanches and the sudden forgetfulness of elderly land owners who would strike pay dirt if their land was zoned for

Figure 5: The Memorial Cross

construction. A young town planner who worked on the POS in the Montroc sector recalls a very strong financial pressure for development in the valley. There were indeed some doubts about the PZEA but it wasn't within their brief to revise the document.

The journalist Bernard Frédérick, writing in the left wing newspaper *l'Humanité*, refers us to the oral tradition used by the mountain folk when selecting building plots. The post war urbanism and agricultural displacement broke the chain of local knowledge passed through the generations. Frédérick also sees the change in the mountain environment as playing a role. Felling of ancient forests to build ski pistes, lifts and pylons, the developments in agriculture, can all play a role in altering the nature of, and even the areas prone to avalanche.

It seems that some locals did remember the earlier dangers. Jean-Claude Charlet, the son of Armand and an opposition councillor, owns a chalet at the Frasserands on the other side of Montroc. The day before the accident he told his guests not to venture past the Becs Rouges hotel. "*With time we forget about avalanches... since the 60s there has been an enormous financial pressure... today there are over 200 houses in blue zones in the valley*". Michel Charlet dismisses these claims as campaigning by a political opponent. However other people were also warned of the dangers, some left for Argentière further down the valley, others chose to stay put. Amongst them was Daniel Lagarde, a specialist in avalanches who, along with his wife and granddaughter, would become a victim.

The press has also engaged in a great deal of hyperbole about the snowfall of 1999 being a once in a century event. François Sivardière of the ANENA states that the snowfall that caused the Montroc avalanche was remarkable but not exceptional. "*In 1988, 2 meters of snow had fallen over just a few days in the area and nothing happened*". French Government meteorologist Jacques Villecrois agrees that the level of snow was not the only factor. In 1999 the Mont Blanc massif was at the epicentre of events but the winter was not unique. Four other winters in the previous 30 years had seen similar levels of avalanche activity. Villecrois identifies a sequence of events, a fragile early season base which meant that any avalanche would break over the full depth and area of the snow pack. The heavy snowfall down to the valley floor meant that features that could slow the avalanche were buried. The very cold weather led to the formation of a powder avalanche. This could start spontaneously, and not due to the passage of a skier that many had assumed at the time and which led to the State Governor (Préfet) imposing a ban, albeit temporary, on off piste skiing. A powder avalanche would have the mass and speed to overcome the false plateau situated at 1900 meters and often follow paths different from norm. Slides from the summit of Péclerey generally took a route 20 to 30 degrees to the north in the direction of Le Tour.

In the light of this information, it seems that the Avalanche Consultative Committee did the best job it could in an almost impossible situation. Who would take the decision to evacuate people in a white zone when there were a good many houses in high risk areas? The avalanche itself was extremely rare, almost to the point of being unpredictable. Cemagref even draw some doubt over the extent of the 1843 slide, stating that the exact location of the Le Tour road is uncertain at that time.

As is often the case, it seems that Chamonix suffered from being a pioneer of avalanche planning. The later revisions to the CLPA show that local knowledge was eventually noted. The usual inertia in administration meant that these changes did not filter through to the planning documents. It may also have been politically difficult for the administration to remove planning permission that had so recently been granted. Landowners took advantage of these errors: the enormous development in the ski industry meant that almost worthless land now had a considerable value. By the 1970s the previous avalanche would have been a distant memory in the community. People could sell the terrain in the knowledge that the expert from the government had pronounced it safe. The fact that the dangers were not readily apparent is witnessed by the avalanche expert who stayed in his house on the day of the accident.

Four years later I'm back at Montroc. Late in the afternoon in early May the village is peaceful. A small memorial cross and the concrete foundations of chalets are the only clues to the events. The mountain behind looks steep and all too close. But where in the valley isn't? The avalanche map is covered in red ink.

The winter of 1970 saw over a hundred deaths; we had to wait thirty years for another major tragedy. Over that time, development in the Alps has been considerable. The measures adopted by the authorities after 1970 can be viewed as largely successful but not without errors. Will there ever be another Montroc? Probably. As long as man continues to venture into and live in dangerous areas: mountains, flood plains, in earthquake zones, there will be accidents. Despite our technology and knowledge we remain insignificant when confronted by the forces of nature.

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Glossary

PZEA, Plan de Zonage d'Exposition aux Avalanches: Avalanche Zoning Plan
CLPA, Cartes de localisation probable des Avalanches: Maps of likely avalanche sites
POS, Plan d'Occupation des Sols: Area development plan
PER, Plan Evaluation des Risks: Risk Evaluation Plan
PUD, Plan d'Urbanisme: Town Plan

David George is an enthusiastic backcountry skier as well as a member of the French Avalanche Association (ANENA). He has a keen amateur interest in the mountain environment and avalanches in particular.

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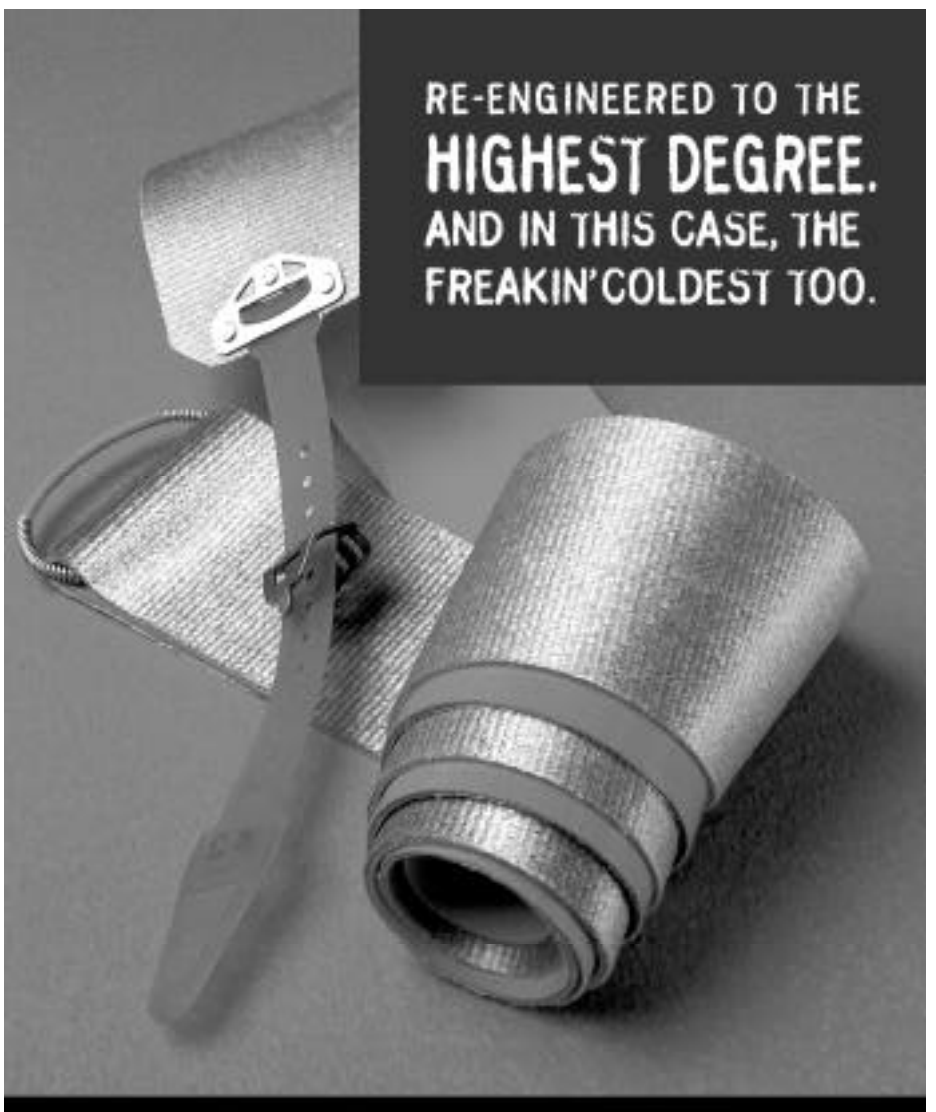

SNOW SCIENCE

Avalanche Hazard Mapping in Kazakhstan

By Viktor Blagovechshenskiy

Editor's Note: This article is the first of two articles describing avalanche issues in Kazakhstan; the second article will appear in a forthcoming issue.

Introduction

Hazardous avalanche terrain in Kazakhstan occupies about 134,000 km^2. Avalanches occur in the mountain ranges of: Altai, Saur, Tarbagatai, Dzungar Alatau, Zailiyskiy Alatau, and the Tien Shan Mountains. The most damage from avalanches takes place in Altai and Zailiyskiy Alatau where mines, ski resorts and roads are situated in avalanche prone zones.

Avalanche hazard mapping is an inexpensive and effective measure of avalanche damage prevention. In Kazakhstan, the Institute of Geography of Academy of Science carries out such mapping using methods based on analysis of terrain and climate conditions, historical data and field investigation. Avalanche hazard maps of small, middle and large scales are compiled.

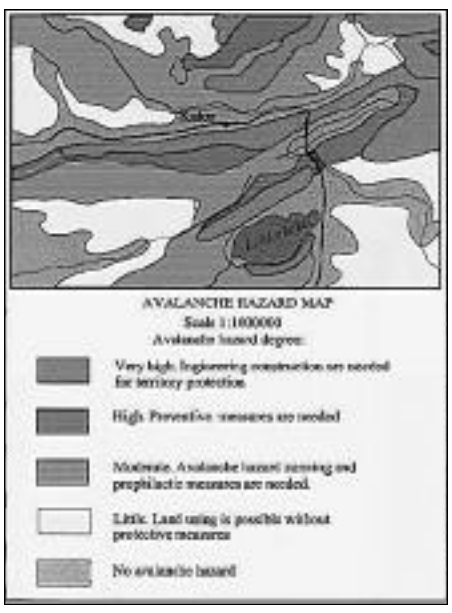

Figure 1. Small scale avalanche hazard map.

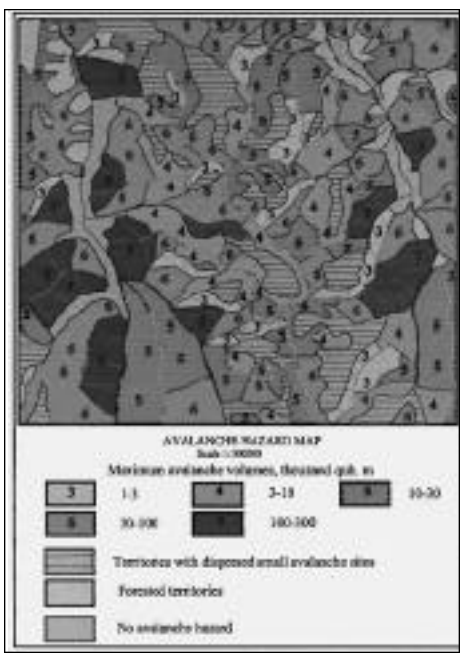

Figure 2. Middle scale avalanche hazard map.

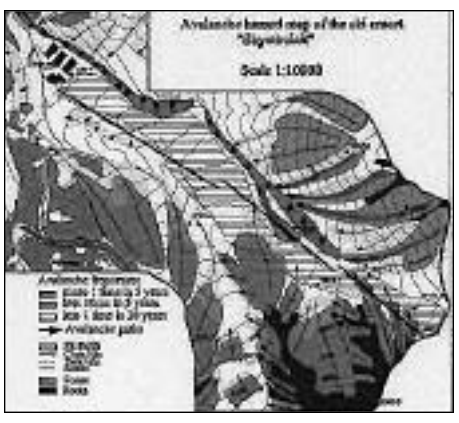

Figure 3. Large scale avalanche hazard map.

Small scale maps

Small scale overview maps of avalanche hazard are drawn up in scale less than or equal to 1:500,000. They contain quantitative characteristics of avalanche hazard level: low, moderate, high and very high (Fig. 1). These characteristics are estimated using data on valley's depth and shape and on the annual maximum of snow water equivalent.

A *low* level of avalanche hazard means that land use is possible without any protective measures. In this territory avalanche volumes (V) are less than one thousand m^3 and the ratio of area hit by avalanches (R) is less than 0.1. A *moderate* level of avalanche hazard characterizes the territories with V 1,000 – 10,000 m^3, and R less than 0.50. On these territories prophylactic measures (avalanche forecast and area closure) are needed. The *high* level of avalanche hazard characterizes the territories with V up to 100,000 m^3 and R more than 0.50. The human activity on this territory is possible with preventive measures (avalanche control). The *very high* avalanche hazard level is marked on the territories where V is more than 100,000 m^3 and R is more than 0.75. Engineering protective constructions (fences, dams, galleries) are needed to protect these territories.

Small scale maps are used by the state and regional administration for elaboration of territory development strategy. These maps had been compiled for all mountain regions of Kazakhstan.

Middle scale maps

The middle scale, regional maps use a of scale from 1:100,000 to 1:500,000. On these maps possible avalanche volumes averaged across avalanche areas (group of avalanche sites) are shown (Fig. 2). Territories with avalanches occurring each year and territories with avalanches in high snow years only (approximately one in ten years), and forested territories with potential avalanche hazards are also marked on these maps. Avalanche volumes are calculated by use of the formula:

$V = KWF$ m^3,

Where: W – annual maximum snow water equivalent in an avalanche starting zone, mm; F – a mean area of an avalanche starting zone, km^3. K – empirical coefficient depending on W. The snow water equivalent is estimated using data from meteorological stations and regional variations of W dependent on altitude and slope aspects. A mean area of avalanche starting zones is determined by using the variations of F dependent on the mean slope height and slope morphology.

Middle scale avalanche hazard maps have been compiled for more developed mountain regions. They are used by regional administrations for land use planning.

Large scale maps

Large scale engineering maps are compiled in scales of 1:24 000 and more. Individual avalanche paths are divided into starting zone, track, and runout zone (Fig. 3). Borders of avalanche runout zones with different return periods are marked. Topographic maps, air photos, historical records, field investigation, statistical and mathematical modeling are used to develop these maps.

Statistical models used for runout distance determination are similar to the Norwegian alpha / beta model. But, significant differences are that runout distance depends not only on ?, but also on avalanche volume (V), avalanche path shape, and avalanche vertical drop height (H).

For channeled avalanche paths:
$tan(?) = tan(?) + (0.25 - 0.012?)lnV + 0.2H2$,

For unconfined avalanche paths:
$tan(?) = tan(?) + (0.007 - 0.005?)lnV + 0.1H2$

Moskalev's model similar to Voellmy's model is used for mathematical modeling of an avalanche runout distance:

$dv^2/2ds = g(sin? - ?cos?) - bv^2$.

Empirical dependencies of the friction coefficient ? and the turbulent coefficient b on avalanche type, avalanche volume V, and on avalanche velocity v are obtained using field data.

For dry avalanches:
$? = 0.1 + 0.4e^{-0.048v}$; $b = 0.13V^{-0.35}$.

For wet avalanches:
$? = 0.36 - 0.13lnV + (0.65 - 0.23lnV)e^{-0.12v}$; $b = 0.006 + 0.15V^{-0.3}$.

Runout distance frequency is estimated according to frequency of an avalanche volume value used for simulation. An avalanche volume frequency is determined using the probability distribution of avalanche volume.

Large scale avalanche hazard maps are drawn up for the ski resort "Shimbulak", winter tourist recreation areas and mountain roads near Almaty. These maps are used by local administration, ski resort and recreation area authorities, and to protect structure designers.

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Editor's note: In the US, identification of avalanche areas is made from maps using a scale of 1:24,000. These maps are commonly available for all mountain regions except Alaska. Risk determination is generally derived from maps in the range of 1:2000 to 1:10,000, such as the "Shimbulak" ski area shown in this article.

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Some Practical Experience and Comments About Snow Strength Tests and Slope Strength Variability

By Craig Wilbour and Rob Gibson

We read with interest Jurg Schweizer's article in the August 2002 issue of *The Avalanche Review* on the rutschblock test. It is prompting an interesting discussion of slope strength variability. We also read Christoph Dietzfelbinger's October 2002 letter to the editor and Jurg's response in the same issue. Howard Conway sent us a copy of his letter on the variability issue that will be published along with these comments.

Snow strength variability is an interesting and potentially personally serious issue for all of us involved in avalanche forecasting and control, and for all winter mountain travelers.

We will use a few of our own few sea stories (or if you prefer, war stories) that support our belief that in some situations there can be quite a bit of variability in snow strength, and that a caution must be used in extrapolating snowpack test results.

About 10 years ago we had been tracking a persistent buried weak layer composed of faceted crystals for some time. We wanted to get some idea what the worst-case snow strength might be. So we went to two locations where we expected the best indication of weakness. During the pervious week, a substantial amount of new snow load had accumulated. The Alpental backcountry had not been open or skied for that week. Rob Gibson and I did two rutschblock tests. In one test on a north-northeast slope, we got a score of 5, with failure at the persistent weak layer. In the other, on a north aspect slope, we got a score of 7+ (both of us jumped on it at the same time). The faceted layer was still only fist hard, however, and temperatures around the layer had equalized at 30 degrees F. On examination, the facets showed that considerable rounding had occurred. The slab above the weak layer was quite stiff. Both of these rutschblock tests were done on slopes where avalanches are common. Or said differently, if we are looking for trouble, these are two of the places we would go expecting to find it.

Alpental conducted their own stability evaluations, and ski and explosives tests and control. They opened the backcountry and people rather thoroughly skied it without incident. So there were three forms of tests. The skiing by the public was the most thorough test, though of course it was not opened to be a test; rather, all forms of test results indicated that it should be open. That night a substantial natural slab avalanche released on a north aspect slope very close to where the rutschblock score of 5 was obtained. The slope that avalanched goes over a cliff that is occasionally used by huckers. More importantly, it ran out and deposited deeply into a gully that is a fairly popular run. There had not been a substantial change in conditions. The two rutschblock tests and the natural avalanche were all within a quarter mile of each other, on north through north-northeast aspects, and all at almost identical elevations. Fortunately, the huckers chose other cliffs that day. Both of us have viewed test results since this with more caution.

In another example: this past spring, opening of Chinook Pass proved very interesting. Chinook Pass (SR 410) is a highway that goes across the Cascades around the northeast side of Mt. Rainier. The winter was mild, and the spring snowpack was predominantly partly frozen (partly ice bonded) MF grains. Light daily snowfall occurred every day during the workweek for the first six weeks of the pass opening project. Our work includes avalanche control to protect the maintenance workers, to reduce the hazard, and to reduce the duration of the hazard after the highway is opened; we also mark the road location with a backpack mounted GPS. We had created (forced) some large slab avalanches with buried 13 and 26-pound shots. Often we bury a line of this size shots across the upper part of a starting zone. This has proven effective for us in a spring snowpack. We had produced a number of wet loose avalanches with skis that further down the slope became large but did not pull out slabs. There had also been natural loose snow avalanches. One day Rob and another member of the crew were marking the road location with GPS. They stopped at a protected point to watch a shot that the other two of us had set up on top of an adjacent peak. Just in front of them they observed a very small natural sluff that descended almost 1000 vertical feet without gaining size. Then just above the road it pulled out a 3-foot deep slab. About two acres of the slab was above the road and half an acre released below the road. A number of subsequent snow pack tests, in a number of areas, failed to even show the layer that released.

These tests also failed to identify the layers that avalanche control released. On a slope not far from where the slab pulled out (as close to it as we felt comfortable), we got a rutschblock score of 28. What's that — the scale only goes to 7? For some years now we have found it useful (particularly in a partly frozen MF snowpack) when getting a score of 7 to then 1/4 the size of the already used sample and jump on it again. This may locate and quantify shear planes that the full rutschblock test does not. Ok, go ahead and quibble with the math, but the point is that we put a lot of force on a small area of the snowpack. This quarter rutschblock test needs more refinement and description of the results because, for example at the 28 score, sometimes our feet blow through the sample without creating a shear and other times they do not. A separate shovel shear test about 100 feet from this rutschblock site failed to locate the slab failure plane also. The same results occurred with a shovel shear at the described rutschblock site.

We realize that rutschblock tests are not supposed to perform as reliably in this type of snowpack, but we are convinced that we were looking at a wide range of snow strength variability between the site of the slab, the rutschblock site and our other test sites. Subsequent avalanche control at the top of this peak yielded many large avalanches; some removed 8-10 feet of snow. Typically each shot was a line of buried charges as described above. In one case, two large avalanches ran over a slab that stayed in place. This slab was later released by loading it directly. In the general area near the road where the slab was released by the sluff, large, control-produced avalanches from above released some additional slabs of similar depth to the slab released by the sluff. The same thing occurred on an adjacent peak, with large avalanches pulling out additional slabs further down the path. The area between the peaks did not produce the same magnitude of avalanches. A few lines of buried charges failed to produce avalanches. These were adjacent to slopes that did avalanche with the same mistreatment. We spent the spring being very conservative and careful. We also used a lot of explosives to protect our ascent routes. This spring we experienced by far the worst correlation between slabs released and snowpack tests that we can recall.

Part of a natural slab avalanche that was triggered by a sluff above SR 410, Chinook Pass, WA. April 2003. The slab released above and below the roadway, shortly after putting in the GPS line (see the sticks). Photo by John Stimberis.

Explosives are a form of snow pack test that puts a measured amount of force into the snowpack. Sometimes the results of avalanche control with explosives are quite variable. We believe that most avalanche control workers have occasionally experienced the same variability in control results. So why shouldn't we see some variability in our snowpack tests?

We like the rutschblock test for all the reasons that Jurg described, particularly because it uses a skier or boarder as the test force. If we had rutschblock scores from all of the places where we have thrown shots, prior to the shot, we would all certainly have a better understanding and feel for snow stability. However, we think that there is good evidence that there is more variability than Jurg describes. We also think that more caution should be used in extrapolating snowpack test results.

We feel that most of the time tests, particularly the rutschblock, give a good indication of the general stability. But most of the time is not all the time. If most of the time happens often enough, we can start to think that it is all the time. Then a rare, but not so subtle reminder such as the above occurrences — with poor correlation to tests — tells us to be careful.

We are interested in the experiences of others involved in avalanche control. Are other avalanche control workers are occasionally seeing poor correlation between rutschblock scores or other snowpack tests and natural avalanching (or for that matter avalanche control)? Do these poor correlations occur more often in specific snowpack types?

Respectfully,
Craig Wilbour and Rob Gibson
Washington State Dept. of
Transportation, Avalanche Control

Craig Wilbour started doing avalanche control as a patroller at Alpental in 1968-69. He was the assistant pro patrol director there from 1970-75. WSDOT hired him as an avalanche control tech in 1975; he has been the avalanche control supervisor on Snoqualmie Pass since 1978.

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Spatial Variability Revisited

By Howard "Twit" Conway

I read with interest the letter from Christoph Dietzfelbinger (*The Avalanche Review* 21(2), 2002), which raises important issues about the application and interpretation of slope stability tests. The response by Jurg Schweizer (same issue) left me concerned that past work and experiences are being forgotten. Here I review some earlier work that indicates (i) variability of snow stability across and down slopes should not be underestimated; (ii) results from a single test of stability can be deceiving.

Plenary theoretical studies and observations by Ron Perla and Ed LaChapelle in the 1970's showed that a zone of deficit (where the downslope weight of a slab is not fully supported at its bed – also termed a "super-weak" or "sweet" spot) is necessary (although not sufficient) to initiate a dry slab avalanche (Perla and LaChapelle, 1970; Perla, 1980). Subsequent measurements and more rigorous analyses by Dave McClung showed that under certain conditions, zones of weakness at the bed might expand in size even without additional loading (McClung, 1977; 1979; 1981). Loss of support at the bed means that support has to come from the upper, side, and lower boundaries of the slab; fracture occurs when the forces acting to release the slab exceed the strength at all boundaries (McClung and Schaerer, 1985). For snow types commonly found at fracture lines, theory indicates that slab avalanches, especially soft slabs, can initiate from a zone of deficit that is just a few meters in length (Gubler and Bader, 1989; Bader and Salm, 1990; Conway, 1998). As Christoph pointed out, this has important consequences for field practioners who try to estimate slope stability from just a few tests.

Our field observations and measurements (Conway and Abrahamson, 1984) support the theory. We wanted to examine conditions on unstable slopes, so we ski-cut avalanches on small slopes and then made tests across the crowns or down the flanks within a few hours (to minimize the effects of sintering). We first dug back about 1m from the fracture surface (to reduce the effect of possible disturbances during the release) and then placed a large frame (30x30x5cm) at the surface before isolating a column of snow from side-shear and tensile hold-up to a depth that was below the bed surface. This method effectively (i) maintained the conditions of natural loading, and (ii) minimized disturbances at the weak layer. Figure 1 (adapted from Conway and Abrahamson, 1984) illustrates the test method.

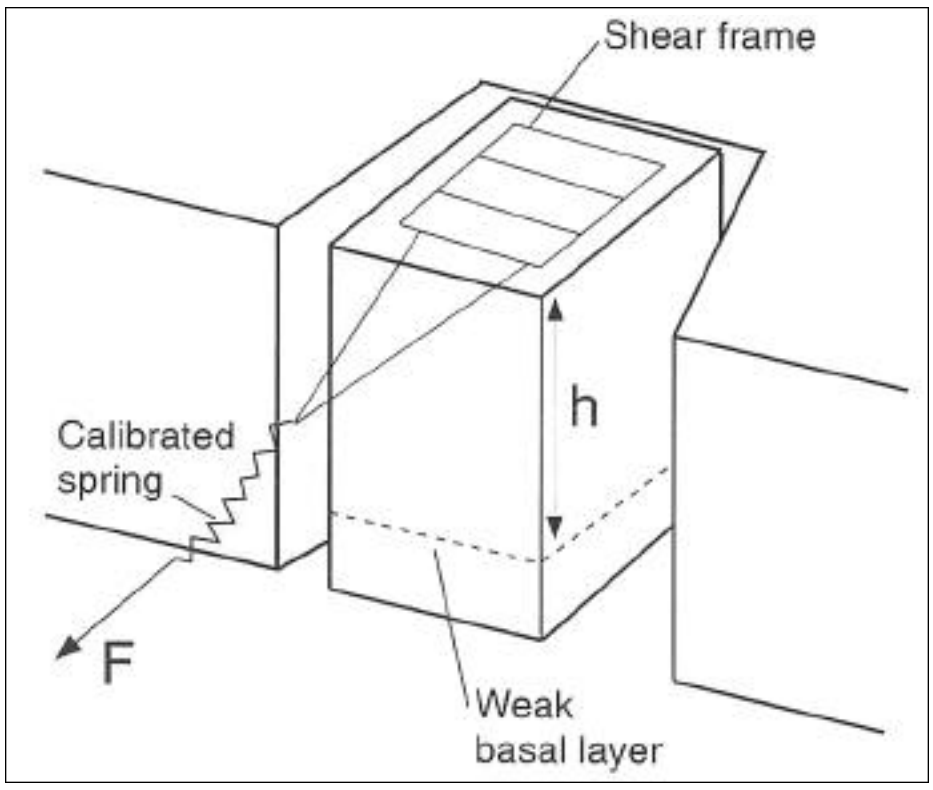

Figure 1. Schematic of test method. The average gravitational stress at the weak layer was estimated from:, where is the average slab density (kg/m^3), g = 9.8 m/s^2, h=slab thickness (m), q=slope angle. Basal shear strength was calculated by isolating the sides and back of the column and using a calibrated spring to measure the additional stress needed to cause the column to shear. That is:, where was the area of the sliding surface.

We called the ratio of the shear strength to the shear stress, the shear index: . At locations where the column failed before it could be fully isolated, the basal strength was less than the stress, and the shear index was less than 1. That is: , which can be written ; the downslope stresses from the overburden are not fully supported at the bed and we call this a zone of basal deficit. Figure 2 shows results from a series of 18 tests made 0.9m apart across the crown of a slab that had been ski-released near the right-hand side on July 13, 1982. For display purposes, we assign the shear index a value of 1 in zones of deficit.

In this example, for conditions of natural loading the regions from 0-0.9m, 1.8-3.6m, 4.5-5.3m, 6.2-7.1m, and 12.5-15m are zones of deficit (). Regions from 0.9-1.8m, 3.6-4.5m, 5.3-6.2m, and 7.1-12.5m are supported at the bed, but the fracture propagated through these pinned areas. The mean shear index , but values vary considerably over distances of a few meters. *Based on these results, and results of tests on other slopes, we argue that the distribution of the weak (deficit) zones is more diagnostic for evalu - ating slope stability than the mean value (Conway and Abrahamson, 1988). In addition, a single test is generally not adequate to charac - terize the stability of a slope.*

The effects of additional stress from static loading from a skier (shown in Figure 2) show that a skier can have a strong effect on the stability index (at least locally), especially when the slab is thin (Fohn, 1987). In this example the skier effectively increased both the magnitude and the area of deficit zones. Note that loading from a skier is concentrated beneath the skis and so other things being equal, a skier traversing a slope has only a local and transitory effect. Also, a turning or falling skier is expected to have a greater effect than that of static loading from a skier traversing (shown below).

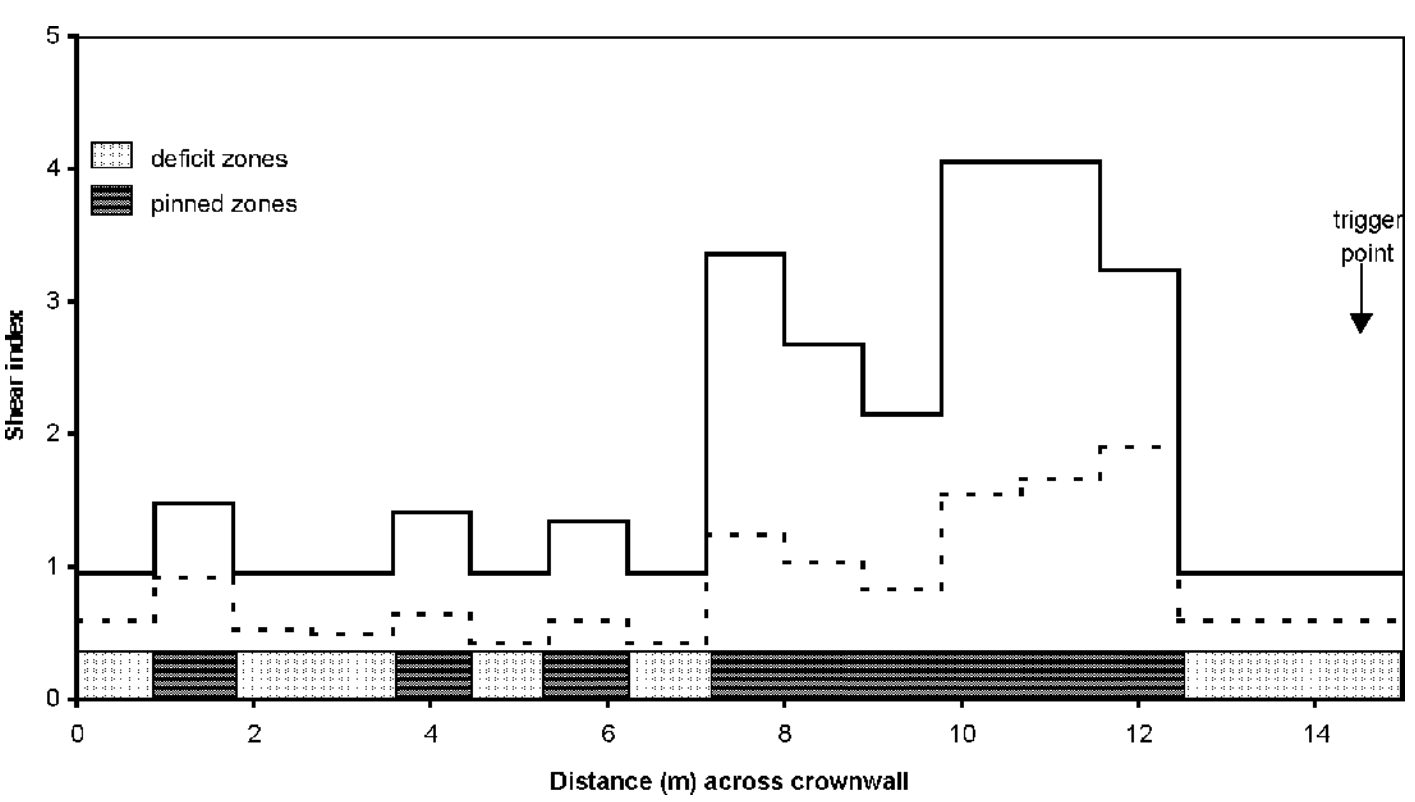

Figure 2. Shear index across the crown wall of an avalanche on July 13, 1982. Slab thickness varied from 0.32-54m, = 140 kg/m^3, average slope angle q = 47^o. The solid line shows variations of the shear index calculated using methods described in Fig.1. Also shown (dashed line) is an estimate of the local and transitory effects of static, line loading from a skier (following Fohn, 1987).

I agree with Jurg (*The Avalanche Review*, 2002) that our tests are not fully conclusive. Firstly, our approach is limited because tests were made along the boundaries of failed slabs; it would be better (although more dangerous) to do tests in the middle of unstable slopes before they avalanche. Secondly, mechanical properties are rate dependent (McClung, 1977) and in our case, although test-rates were similar, they were not controlled; our method yields an *index* of stability. Thirdly, the method does not allow an estimate of basal shear strength when it is less than the driving stress; we only know that it was less than the driving stress and hence it was a zone of deficit. We also note that applying the force at the top of the column imposes a bending moment. On some slopes where the strength was much higher than the stress, columns would fail by bending rather than shear. In the above example the stress needed to cause failure in simple shear was likely higher than that calculated from our test.

I disagree however, with Jurg's statements: (i) in *The Avalanche Review* (2002): …. *we might all have in the past slightly overestimated the amount of snow-pack variability*… and (ii) in Schweizer (1999): … *there is no indubitable evidence for small deficit zones from field studies by Fohn (1989) and Jamieson (1995). This finding is even supported by Conway and Abrahamson (1984) considering their rather arbitrary interpretation of test results.*

Firstly, our measurements do show considerable variability (including small zones of deficit) over short distances (see for example results in Figure 2). Secondly, apparently Jurg believes that any columns that fail prematurely must have been disturbed during preparation and maintains that results from those tests should be disregarded. Given the theory and observations I am astonished and concerned by this interpretation. Apart from the results shown in Fig. 2, I have (or should have) taken heed of warnings indicated by columns failing under their own weight on several occasions. The most notable was just prior to starting down a superb slope on Tripp Mountain in the foothills of New Zealand. The first and second shovel-shear tests required additional force for failure. The third and fourth columns failed before they could be completely isolated. The fifth, sixth and seventh columns required additional force for failure. Two out of seven indicated zones of deficit. For some reason I decided to ski across to some rocks and re-evaluate. Wrong decision, although I did re-evaluate my interpretation of the tests as I tumbled with the avalanche toward the sheep below.

I first met Sue Ferguson digging snowpits and I asked her recently about her experiences with columns that failed before they had been fully isolated. Her response:

it hasn't happened often but does occur. One memorable experience was in Alaska, when I dug a 14' pit and before I could get my saw all the way through the back, it failed on a weak layer 13' from the top. Whew!@#&. Next day a huge avalanche was triggered near the ski area with a 1-lb hand charge that destroyed 100-yr old trees. The fracture depth was over 10 feet and appeared to be on the same layer that jumped at me the day before*.

In his little gem (*The ABC of Avalanche Safety*) Ed LaChapelle wrote about shovel-shear tests … *if the shear plane fails under its own weight without shovel help when the column is exposed, the snow is definitely unstable. Be careful*.

I strongly endorse Ed's remark - be careful!

Howard Conway is a Research Professor in the Earth and Space Sciences Department at the University of Washington. His research interests and expertise are broad: a history of the West Antarctic Ice Sheet, glacier response to climate change, and avalanches. His avalanche research has included a dozen papers and ISSW presentations focused for the most part on spatial variability, wet snow, and rain-on-snow events.

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Continued from cover

ing in grant writing and dealing with the media, two things that are becoming essential for running a successful avalanche center.

In addition to supporting the Forest Service avalanche centers, we continue to work with other avalanche programs. This season Glacier National Park hired two forecasters and established an avalanche forecasting program for their spring opening program on the Going to the Sun Road. The NAC provided some technical expertise and advice for some of the unique problems they face, like numerous wet snow avalanches, and frequent cycles of large wet slab slides.

In terms of technology transfer, the NAC continues to cooperate on a number of different studies as well as to provide the best possible information on scientific advances and new tools to the U.S. avalanche centers. We are currently working with eight different graduate students from Montana State University and Colorado State University and, in addition to working with researchers from both of those schools, we continue to collaborate closely with scientists from the Swiss Federal Institute for Snow and Avalanche Research. The wide variety of our projects has led to many papers, including eight poster and paper presentations that we authored or co-authored at the 2002 International Snow Science Workshop in Penticton (see http://www.fsavalanche.org/NAC/techPages/techPap.html for a list of all our papers and several links to papers and student theses). Our primary focus for the coming winter involves continuing studies of spatial variability using stability tests and the Swiss SnowMicroPen, an instrument we continue to use and evaluate. For more information on our projects, and on the NAC's Tech Transfer program, visit our website at http://www.fsavalanche.org/NAC/techPages/index.html.

We continue to collaborate closely with the Swiss Federal Institute for Snow and Avalanche Research (SFISAR) on a number of different levels. Doug visited Davos last Spring, and shared information with their scientists and forecasters about the use of different devices for avalanche mitigation work. He also laid the groundwork for a possible forecaster exchange program between SFISAR and the U.S. avalanche centers that we are still working on. Karl attended an International Glaciological Society meeting in Davos in June, and further solidified the connections between the NAC and many of the SFISAR research scientists.

In December, Mammoth Mountain experienced two massive 106 Recoilless Rifle in-bore explosions. Luckily, the Mammoth crew was shooting the 106 from behind a protective barrier during both incidents, and no one was injured. Had the crew not been behind the barriers, it seems inconceivable that there would not have been injuries of the most serious magnitude. The NAC worked closely with the Army, Nat Heit from Mammoth Mountain, Mike Schlaffmann from the Mammoth Ranger District and Bob Moore the FS Region 5 Artillery Coordinator following the incidents to assure that all users were notified immediately and that all use of 106 rounds was temporarily suspended. All military artillery for avalanche control users have eliminated the 106 RR from their programs and the NAC is working with the individual ski areas, ranger districts and the Army to assure that those programs will have replacement systems for this coming winter.

This past winter, the Office of Homeland Security, through the Office of Inspector General, audited the Forest Service explosives program. The audit included FS permitted ski areas and helicopter ski guide concessions' use of hand charges for avalanche control and the FS managed military artillery for avalanche control program. The NAC coordinated the military artillery portion of the audit and the NAC and ski areas with military artillery are currently working to comply with all the audit findings.

Bruce Tremper, Director of the Forest Service Utah Avalanche Center, measures the slope steepness on a skier triggered avalanche on Cardiff Peak, Wasatch Range, Utah. Photo by Drew Hardesty U.S. Forest Service Utah Avalanche Center.

The NAC worked in conjunction with Bob Comey and the Jackson Hole Snow Safety Group and the Bridger-Teton Avalanche Center to provide training at the Forest Service Snow Rangers and Winter Sports Administrators Annual Meeting. The training included in-area explosives use and route safety and out-of-area snow pack and terrain assessment, decision-making and search and rescue. The next Snow Ranger Meeting will be in February in Aspen.

And speaking of meetings, the next Backcountry Avalanche Center meeting will be October 1-2 at Snowbird, Utah. It will include a business meeting and a technical seminar. Anyone interested in further information should contact either Doug @ dabromeit@fs.fed.us or Karl @ kbirkeland@fs.fed.us.

So, here's to another safe and productive year in the snow that includes more than a few good turns!

— Karl Birkeland

Alaska: Chugach National Forest Avalanche Information Center

The Chugach National Forest Avalanche Information Center (CNFAIC) kicked off its rookie season this past December. The Center is based on the Glacier Ranger District, in Girdwood, AK. The CNFAIC mission is to increase avalanche awareness in the Turnagain Arm Area through avalanche education and advisories. We strived to accomplish this goal this year by posting 93 advisories and teaching six avalanche classes to 121 participants. The advisories were available to the public Wednesday thru Sunday by 8 AM on the Internet and via phone-in hotline. The avalanche awareness classes were held on Thursday nights at the district office. In addition, the Chugach Forest interpretive staff brought the message of avalanche safety and awareness to over 500 students at local schools.

The Center's advisories focus primarily on the Turnagain Arm area, and Turnagain Pass in particular. The eight-mile section of the Seward Highway that winds through Turnagain Pass can see as many as 300 vehicles on a weekend day. This amounts to approximately 750 motorized and non-motorized backcountry travelers per day.

We have seen a great show of support for the CNFAIC from the Forest and the community. The number of phone calls to the hotline and the visits to the web page increased greatly throughout the season. The backcountry community recently rallied to show support by forming a "Friends of the CNFAIC." They hosted the first annual telemark festival and have great plans for the future. The Center has support from the Alaska Railroad, Alaska Department of Transportation, Alyeska Resort, and volunteer observations.

— Carl Skustad

Alaska: Southeast Alaska Avalanche Center

Southeast Alaska had the closest thing to a non-winter that any of us have ever seen. Eaglecrest ski area and the snowmachine trails opened for a week at Christmastime, then lost their snow when a series of tropical storms tracked straight at us, bringing warm air to the North. Daffodils grew tall outside the Center office in early February, but late snow and a cool spring finally allowed the ski area and snowmachine trails to reopen in late February.

With the lack of snow, avalanche activity was minimal and confined for most of the season to the northern panhandle and higher mountains. In April, we finally had some cycles in the Juneau area, and large avalanches in the higher mountains. As of press time, there have been four avalanche deaths in Alaska this year: one snowboarder and one skier in South-central; and two climbers missing and presumed killed by an avalanche in late April on Devil's Thumb, near Petersburg in Southeast Alaska.

Our staff this year was director and senior avalanche specialist Bill Glude, assisted by avalanche specialist Peter Carter and our student intern Kent Scheler. We trained a number of awareness instructors to help cover Southeast Alaska, including Karl Bausler, Scott Burton, Sarah Carter, and Brooke Munro in Juneau, Ryn Schneider in Petersburg, and Coleen Harrier and Tamar Young in Haines.

Course attendance was down due to lack of snow, but we still reached over 750 people, mostly in awareness courses. The weather station at our Fish Creek Knob snow study and research site, which we operate in conjunction with the University of Alaska Southeast, is now fully operational. It is the only higher elevation site in our region with radiation and acoustic snow height sensors. Solar panels and telemetry are going in this summer, and the site should be on the Internet next winter. Our experiments this winter included creep columns and layer tracking with strings on an avalanche slope, gradient monitoring with a temperature probe, dye percolation studies, and test block evaluation. Of particular note was two weeks of detailed test block evaluation in Valdez, with support from Valdez Heliski Guides.

Future funding is still an unknown. We had to cut our operating season short as several key grants fell through, and despite much hard work at the state, federal, and local level this year, we have no assurances at this time.

— Bill Glude

California: Shasta-Trinity National Forest Avalanche Center

Our 2002-03 winter started off with a record setting stormy December that brought almost half of the season's snow and water. Wind events in excess of 70 mph and two-three inches of snow per hour during the month brought us our largest avalanche cycle of the season. We saw one large class 4.5 avalanche run in Avalanche Gulch on the SW side of the mountain. The starting zone was around 12,500' and it ran all the way down to 7300'. The debris is expected to linger into autumn. January and February were fairly warm and dry with a wind event in February that produced NW winds up to 90 mph. March brought a few storms before April dumped over 120" of snow and 11.9" of H20, making for a great snowpack for spring skiing. April gave us an impressive natural avalanche cycle with multiple class 3 slides. One in particular on the North side of Grey Butte had a 1/2 mile crown and ran in 95% of the potential path. This large event slid on a weak layer of surface hoar resting on top of a weakening crust.

We saw several snowmobile-triggered avalanches with no known injuries. There were a dozen skier triggered slides and three snowboard triggered slides, again with no known injuries. Overall, we had a fairly safe year in the Northern California mountains.

Month	***Snow***	***Water***
December	210"	17"
January	40"	7"
February	39"	4"
March	68"	6.8"
April	120"	11.9"
May	8"	.8"
6 Months	485"	47.5"

Our center issues avalanche advisories November through mid May, and we issue climbing advisories year-round. We saw over 65,440 hits this past season on our web page and received 3,526 calls on the advisory hotline.

Avalanche classes were very successful, with high attendance numbers and eager students. Educational classes encompassed half our time, reaching out to over 1,000 participants. We were on the road 1 to 2 days a week traveling anywhere from the Bay Area to Medford, Oregon and points in between. Programs primarily consisted of transceiver clinics and awareness programs. In addition to general recreationist classes, we taught specific classes for schools and colleges, snowmachiners, and Search and Rescue.

The Future:

In the future we would like to expand our program in education, weather information, and the forecast area. We look forward to the addition of another avalanche specialist. We continue to receive more education and experience pertaining to the unique weather phenomena that occurs on Mt. Shasta. Expanding our snowmobiler educational program will be very important this next year.

Big Thanks:

We feel very fortunate to have our new family addition, the Friends of the Mt. Shasta Avalanche Center. It is a non-profit organization that was formed by some very supportive locals. They threw a great fundraiser called the "Snowball" that produced over $5,000 to be used for more weather telemetry. Many businesses, local and out of the area, donated prizes, beverages and food. We are also very thankful to the great outdoor companies that donated prizes for the raffle and the silent auction: Black Diamond, Marmot, Patagonia, K2, Shasta Mountain Guides, Sierra Wilderness Seminars, Fifth Season, Ortovox, Backcountry Access and Life Link.

The U.S. Forest Service management has continued to support the program, and we appreciate that very much. Thanks to the National Avalanche Center for their support and guidance. All the observers deserve a huge pat on the back for their invaluable information. Medford NWS did a good job of providing us weather information. Brenda Graham from the USFS Fire Weather Forecast Center in Redding, Ca gave us invaluable guidance and meteorological education. Thanks to the Dept of Water Resources for the excellent weather telemetry, Mike Hupp, Dave Trevisan and Ken Showalter for their support and faith in the avalanche center. Dave, we couldn't have done it without you! Thanks also to Dr. Scott Schmidt from Snowdog Engineering and the Gallatin National Forest Avalanche Center. Last but not least, special appreciation goes to our patient and beautiful wives for putting up with early mornings and long hours.

— Matt Hill

California: Tahoe National Forest Avalanche Center

The Central California Avalanche Advisory program started in December 2002 with a bang. We received large amounts of snow in a storm series that lasted nearly 3 weeks. Very high winds resulted in power outages in the Truckee area. The Forest office lost power for 10 days, which put the Forest Service Servers down. We lost the ability to up-date our web page or post advisories in a timely fashion. As a forecaster I was very concerned about the backcountry stability and our daily snow advisories reflected that. The storms finally eased off, leading to a strange winter weather pattern.

Mike Rheam approaches the summit of Grouse Mountain in the Bridger-Teton National Forest. This automated remote weather station provides ridgetop wind data every 15 minutes from a very popular high marking area known as Dry Lake Creek drainage near the Continental Divide Snowmobile Trail south of Togwotee Pass. Photo by Bob Comey / BTNFAC.

We went into what everyone thought was going to be another drought year until April, which turned out to be our major storm month. April brought 10-12 feet of snow; however we did not issue many advisories due to the relatively benign way the snow came.

At the end of April, a snowmobiler was killed in the Blue Lakes area off of Highway 88. He was high-marking when a class 2 avalanche released, trapping him. There were witnesses and his body was recovered several hours later. He had no safety equipment, nor had he attended any type of avalanche awareness class, although classes are routinely offered in the South Lake Tahoe area.

Thanks to some funding from the State of California, we had the financing available to hire a forecaster to assist in the program. With this additional staff, we have branched out and have been able to pursue grants and seek help in establishing a "Friends" type of organization. We are actively recruiting for someone to step forward and lead the Friends.

Our Tahoe NF web master has been working with us on developing a new format for the Web. We are looking at a more user-friendly approach and plan to achieve greater ease for preparing the daily snow conditions report - stay tuned on this next season.

As I prepare this summary in mid-May, we are still receiving reports of avalanche activity. We posted our end of the year message on May 10, a good 6-month season for us even though we put off starting until as late as possible.

— Bob Moore

Colorado: Colorado Avalanche Information Center

After two years of low snow and poor summer rains, Colorado was suffering a drought that was approaching crisis level for stream flows, reservoir holdings, wildfire, and for the water capacity to sustain cities, people, and wild animals. We needed a good winter in the worst way. It started strong with several storms moving into Colorado in late October. Though we don't have the numbers, the month's snowfall was above normal.

Chris McCollister, Dan Judd, Jim Farmer and Mike Rheam install the Mt. Coffin station, several miles north of Wyoming Peak in the Wyoming Range of the Bridger-Teton National Forest. At 10,800 feet this is the highest weather station in Wyoming. Photo by Bob Comey Bridger Teteon National Forest Avalanche Center.

November continued the healthy snows, at least in the northern mountains (110-190% of normal) and central mountains (100-106%). The southern mountains suffered with only 50-88% of normal snows. During November, the CAIC received reports of 148 avalanches, which was slightly above average. There were 11 avalanche incidents that caught 12 people and injured 3.

December brought below-normal snows that averaged 43-93% of normal throughout the mountains, though a few lucky sites were slightly above normal. Avalanche incidents were minimal: 4 incidents caught 6 people.

January did no favors for skiers, same as last year. Snowfall was poor—54-93% in the northern mountains, 29-45% in the central mountains, and 16-49% in the southern mountains. The backcountry snowpack was rapidly turning to sugar. There were 14 reported avalanche incidents that caught 20 people and injured 3.

February was the first big month for avalanches, all triggered by heavier-than-normal snowfall on top of a fragile, faceted snowpack. Snowfall was 117-176% in the northern mountains, 109-184% in the central mountains, and 95-142% in the southern mountains. There were 13 avalanche incidents that caught 17 people, injured 3, and killed 2. The first death occurred on the 17th when a climber near Loveland Pass was buried and killed, and the second was on the 22nd when a ski mountaineer died on Mt. Belford (a fourteener in the Sawatch Range). There was an extended Avalanche Warning period from February 23 to March 1. The house of cards was stressed to the breaking point.

March was an exciting month, with heavy snowfall in the northern half of the mountains and much lower snow further south. It also brought the largest storm since the Avalanche Center came into existence! A precursor storm on March 4-10 put down a thick layer of slab in all mountain areas, and this produced a rash of avalanches, with 277 being recorded. Two of these were fatal: a snowmobiler was killed on the 5th on Hancock Pass (in the Sawatch Range north of Monarch Pass), and another snowmobiler was killed on the 9th on Cottonwood Pass, also in the Sawatch. On the 8th the CAIC received this note from Mike Friedman of Helitrax in Telluride: "This may be one of the most persistently tender snowpacks seen in the San Juans in my 20 plus years here. Approaching 30 days in a row of Considerable to High avalanche danger in the backcountry."

The big storm hit on the 17th. By the morning of the 18th, this system had set up as a closed low just SE of Colorado, and it sat there for the next 3 days and pumped massive moisture into the Front Range on an easterly flow. Storm totals for the 17th-21st were: A Basin, 63"; Berthoud, 73"; Winter Park, 78"; Bear Lake, 72"; Eldora, 66"; and Rollinsville, 87.5". Further west, storm totals tapered off rapidly: Breckenridge, 41"; Copper, 39"; and Monarch, 37".

Avalanche warnings for an extreme danger were posted on the 18th-22nd. 154 avalanches were reported, but this number does not come close to the actual number of slides that must have run, nor does it convey the extent of the danger. Several known avalanches were exceptional. Here are five examples: A natural hit I-70 in a path that had not run so big since 1948; a controlled slide near Silver Plume destroyed a forest, buried I-70, and had not run so large since 1951; another natural near

Silver Plume caused damage to power lines, a water treatment plant, and the roadway; and slides buried several cars at Eldora and isolated stranded 250 people there for 2 days. In Rocky Mountain National Park, a slide demolished the Chasm Lake shelter, which was built in 1931. On the 20th, an out-of-area skier died in an avalanche near A Basin.

A final fatal avalanche occurred on the 22nd when a snowmobiler near Rico (in the San Juans) was buried and killed. All told in March, there were 20 avalanche incidents which caught 24 people, injured 4, and killed 4. Five cars were reported hit by avalanches on the Eldora access road. There was significant property damage at Silver Plume, in Rocky Mountain NP, and on Mt Goliath, with damage approximating $75,000. Lastly, there was untold forest damage.

March snowfall was 113-280% of normal in the northern mountains, 69-115% in the central mountains, and 68-89% in the southern mountains.

After that excitement, April was unremarkable. Snowfall was near normal, and three avalanche incidents caught 7 people. The CAIC closed on April 21 for full backcountry forecasting but stayed open as needed until May 14 to issue special forecasts for highway operations and for the Friends of the CAIC. May brought three additional avalanche incidents that caught 4 people.

For the season, the CAIC received reports of 2,420 avalanches. There were 68 incidents that caught 90 people, injured 14, and killed 6. Seasonal snowfall was 96-138% of normal in the northern mountains, 79-85% in the central mountains, and 70-96% in the southern mountains.

Finally, as part of our education mission, the CAIC staff taught at 73 classes to more than 3,000 people. We held a variety of programs at schools, on snow and for all members of the public.

— Knox Williams

Idaho: Idaho Panhandle National Forest Avalanche Center

The season of 2002-03 produced a persistently unstable snowpack for the Idaho panhandle region. The increased number of incidents and fatalities give proof. On February 21st, a snowmobiler triggered a large slab avalanche near Jeru Peak in the Selkirk Mountains. Fortunately, the snowmobiler was able to escape since he was close to a flank of the slide. There were no injuries or fatalities related to this event. On February 22nd, two separate incidents resulted in two fatalities. One occurred about 2 miles north of the Schweitzer Ski area in the Selkirk Mountains and involved a group of 5 skiers who were skiing out of a local area hut. The fatality occurred while they were skiing on a southeast slope, and the victim triggered the avalanche on a buried layer of surface hoar. The other fatality also occurred in the Selkirk Mountains 10 miles to the north of the first accident, and within an hour and a half of the same time. This accident involved a group of snowmobilers who were highmarking in an area known as Echo Bowl. The accident occurred on a northeast slope when two riders highmarked above two others that were stuck midslope. The avalanche released on the same layer of surface hoar that resulted in the skier death earlier that day. This layer of surface hoar persisted for several weeks and resulted in very widespread avalanche activity.

On the 8th of March, 6 snowmobilers were riding the St. Regis Basin east of the Lookout Pass Ski area near the Montana border. They were highmarking a slope and had made several runs on it with no release. One more pass and the entire slope released. The rider who was highmarking was able to get off the slab, but the individuals at the bottom of the slope had to outrun the avalanche. They were all buried yet

Glacier National Park Avalanche Specialists (from left) Chris Lundy, Blase Reardon and Mark Dundas investigating the 5-foot crown from a natural wet slab avalanche, April, 2003, Glacier National Park. Photo by Karl Birkeland, U.S.F.S National Avalanche Center.

able to extract themselves from the debris with only a few injuries.

We also received word of a snowmobiler that triggered a large avalanche in the St. Joe Mountains and had to outrun it for quite some distance. It eventually caught up to him and only partially buried him. Undoubtedly, there were other incidents that we did not hear of.

The advisory season did not begin until December 20th, and we issued 22 weekend advisories until April 11th. Of these 22 advisories, we issued only 7 with a Moderate danger rating, 10 with Considerable avalanche danger and 5 with High. Such elevated hazard was pretty unusual for northern Idaho. A new 1-800 phone number allows out of state users to more readily access the phone advisories. Forecasters Kevin Davis, Ed Odegaard, Tom Sudul and director Bob Kasun issued advisories on the hotline and internet, and taught 10 avalanche workshops. At the end of March, snow totals ranged from 85% of average to a bleak 54%. Of note is a review of the avalanche program by the Forest Leadership Team, while the Resource Advisory Committee and the Forest Supervisor are considering additional funding.

— Bob Kasun

Idaho: Payette National Forest Avalanche Center

The 2002-03 season started out with a complete burial and transceiver rescue of a local backcountry skier. This incident, along with an avalanche fatality of a snowmobiler in the mountains southeast of Boise near Fairfield, produced increased requests for and increased attendance at avalanche awareness classes. The snow pack was more or less normal in terms of depth and water content. However, due to somewhat warmer mid winter temperatures, we experienced several rain crusts within the pack. Thanks to two regional wind events (one early and one late in the season), there were two distinct dirt layers within the snowpack to muse over. Two natural avalanche cycles occurred in March. The first one was caused by rapid loading from heavy snow and wind, and ran on density changes within the new snow. The next cycle occurred just 4-5 days later and was caused by a rapid temperature increase with record high temperatures. The slides in this second cycle ran on a buried crust.

High Points: Avalanche awareness classes (two in McCall and two in Boise) were very well attended. Our local Friends organization funded a series of beacon clinics, once a week for five weeks. These clinics covered everything from beacon basics to complex searches. The Avalanche Center had enough money to hire an additional forecaster for the season. We also were able to install a new weather station in our southern reporting area.

Low Points: We are consistently faced with the inability to get snowmobilers to attend field sessions and get hands on experience with stability assessments and route finding. The vast majority of accidents and incidents in our area seem to be this user group, with leaders making inaccurate stability assessments and poor route selection. The weather stations have been a challenge to troubleshoot and keep operational, although we have been making some headway.

— Jim Fitzgerald

Idaho: Sawtooth National Forest Avalanche Center

With early season snow in the mountains, general information advisories began by the end of October. Daily advisories did not begin until snowfall warranted them on December 14th, and ran through March 22nd, with general information issued periodically into early April. Initially we offered six advisories a week, combining Monday & Tuesday due to funding and staffing limitations. In mid January, local supporters offered 2,000 dollars to provide Tuesday advisories until spring. The daily advisories ended a week earlier than usual. We then shifted to general information and were faced with ending these 2 weeks earlier than normal. This was again due to funding limitations. We issued a total of 103 advisories, 22 fewer than last season.

The backcountry offered consistently great powder throughout most of the winter. Conditions became supportive for snowmachiners in mid-January, and were excellent thereafter. Some spurts of corn skiing at lower elevations interspersed the dry spells. Stability-wise, several persistent weak layers and crusts kept most backcountry recreationists off of the steeper slopes and high alpine terrain during times of concern. We issued 4 Avalanche Warnings with the National Weather Service. The first two were near the end of December when a multi-day storm loaded a weak, depth hoar snowpack. A young snowmobiler was killed in a large, triggered slide southwest of our forecast area during this time. His party had no beacons, shovels or probes with them, and a group nearby assisted with their own rescue gear. The second two warnings were related to heavy rainfall on newer snow and isothermal conditions.

Overall, the Sawtooth National Forest Avalanche Center, (SNFAC), had a very successful season. This was represented by no fatalities, no known injuries and only a few close calls, in spite of several extended spells of relatively unstable conditions. This included two full burials and live recoveries. One was a snowmobiler, who was able to claw his way out of a shallow but complete burial in a very large slide. His partners all had rescue gear, and they only had two people on the slope out of a group of 10 because they were concerned about stability. The other burial was a backcountry snowboarder in a narrow gully whose partner performed a rapid beacon recovery. Of note, both burials occurred during Considerable avalanche danger.

This winter, there appeared to be an exponential increase in the number of backcountry recreationists of all types. Once again we observed a dramatic increase in avalanche awareness throughout the local community. Unfortunately, due to funding and staffing, we offered fewer classes and were unable to travel to neighboring forests. In spite of a short season on both ends, advisory use numbers doubled overall, thanks to the popularity of e-mail and increased web accesses.

Two new forecasters came onto the scene this year: Greg Johnson, formerly of the Logan, Utah-Bear River Avalanche Center, and Jay Gress, our local field assistant and web designer. They brought great skills, dedication and expertise to the Center. Forecasters Pat Deal and Anne Marie Devereaux moved on to other careers and the opportunity to spend more time with their families. We miss them and wish them the best of luck. Steve Conger, contracting with Idaho Transportation Department added a level of professional snowpack observations and analysis that had not been available for Banner Summit and Highway 21.

An exciting, and long awaited, improvement this season was the new Lower Titus weather station. It provides, via our internet pages, real time temperatures and snow depths for 9,100 feet in the Galena area. Other improvements were the use of PowerPoint for class presentations. For next season we completed the development of a digital picture interface for inserting recent photos in advisories. We also printed snowmachine avalanche awareness brochures in conjunction with the Gallatin Forest Avalanche Center.

Funding remains an ongoing challenge. Disappointingly, we did not receive several grants that we applied for, but in the future we hope to partner with the BLM and Idaho State Parks and Recreation. Very generous grants from The Sawtooth Society, The Little Sprout Foundation, The Idaho Community Foundation-The Deer Creek Fund, and Backcountry Access, assisted our programs throughout the season.

— Janet Kellam

Montana: Gallatin National Forest Avalanche Center

The winter of 2002-03 was one of the more interesting avalanche seasons since the start of the Avalanche Center in 1989. The lean amount of snow that fell in our advisory area during the month of October was subject to a prolonged period of very cold temperatures at the end of the month. This resulted in 8 to 12 inches of well-developed facets throughout our entire region. It continued to be dry through November, and temperatures remained just cold enough to preserve these facets at higher elevations. The month ended with unusually warm temperatures, capping the facets with a "Thanksgiving" ice crust.

This set the stage for the rest of our season. A layer of faceted crystals developed on top of the Thanksgiving crust early in December, and a subsequent storm cycle, (depositing 3 inches of water in the southern mountains over a 3-day period which started on the 28th), was accompanied by 3 full, and 2 partial burials in the mountains north of Cooke City. This storm cycle continued into the early part of January, with the southern mountains getting snow continuously until the 6th. Six days of clear weather formed a well-developed surface hoar layer in the southern mountains.

New snow, starting on January 12th, brought another rash of human triggered avalanches near Cooke City, with 7 more full burials including the first fatality on the 22nd. This avalanche cycle ran primarily on the surface hoar layer.

The southern mountains received 8.5 inches of water from January 23rd to February 4th, resulting in the longest period of continuous avalanche warnings in the center's history, and many avalanches that ran to the ground. Record snow fell in the northern mountains in early February, and fatalities in the Crazy Mountains, (just outside our advisory area), as well as a fatality near Helena, were reminders of the continued instability that was prevalent in our snowpack. Record snowfall continued into March and unfortunately resulted in the fourth, and final, Montana avalanche fatality. This occurred on March 9th near Cooke City.

Reggie "The Powder Dog" on his first control mission for CAIC/CDOT on Red Mountain Pass. On left is Mark Regin, a forecaster from Chile. Proud parent Jerry Roberts of the CAIC to right. Photo by Bill Glude, Southeast Alaska Avalanche Center.

Despite the record low snowpack early in the season, southwest Montana ended the winter with above average water in most drainage basins.

In all, we had 40 reported human triggered avalanches in our area that resulted in 19 burials, 3 fatalities, and 1 serious injury. A total of 4 avalanche fatalities occurred in Montana this season. Given the large number of burials, we feel very fortunate for the relatively low number of fatalities, especially given the persistently weak snowpack we experienced this winter.

A slow start to the winter also meant a slow start to our forecasting season. Regular advisories did not start until December 23rd, with 112 advisories issued by the close of business on April 13th. The popularity of our product continues to increase, and even with the reduced number of advisories, the average daily access increased 22% over last season. This year we had a combined email, web and phone access averaging 1,577 people per day.

Educational efforts also increased this season, with 59 talks / seminars or field sessions reaching 3,302 people, compared to 2,700 the previous year. Part of this increase is attributed to Chris Lundy, who contracted through our Friends group to teach several one-hour awareness courses. We talked to search and rescue groups, ski patrols, all the seventh graders in Bozeman, Montana State University students, snow groomers, and various ski and snowmobile clubs. Of significant note: our multi-day snowmobile courses, offered in Bozeman and West Yellowstone, increased in attendance for the 3rd straight year, up 40% from last season. Once again, Polaris and a local snowmobile shop donated two sleds for our use this winter, making this educational outreach possible.

— Scott Schmidt

Montana: Glacier Country Avalanche Center

For Northwestern Montana, the winter of 2002-03 began with a cold snap at the end of October. This appeared to predict a return of cold winters, something we hadn't experienced for several years. The change was short-lived as mild temperatures and mostly dry conditions quickly redeveloped. November through January saw well below normal precipitation and when moisture did invade, it often produced rain and wet snow. It was February and the weakening of El Nino in the Pacific before our weather pattern began to smooth out and become more typical. Much of the season's snow pack actually developed in March and April.

A shallow snow cover coupled with the erratic nature of the early and mid season storms lured many recreational users into areas seeking the "steeper and deeper." Here several backcountry parties got mixed-up in avalanches. Fortunately none of the incidents involved fatalities or serious injury. March 12-13 saw a significant avalanche cycle along the southern edge of Glacier National Park. For two days, traffic on U.S. Highway 2 and the adjacent Burlington Northern- Santa Fe Railway west of Marias Pass was suspended.

The avalanche center continued this year its normal program of twice weekly avalanche advisories and its normal program of education classes. The non-profit side of the program hosted their second year of level II classes, (assisted this year by Northwest Avalanche Institute), along with numerous transceiver clinics and awareness classes. These were all well received. Their web page continues to experience increased use as it provides access to our advisories and a forum for backcountry observation reports. The Forest Service received another substantial Montana Department of Fish, Wildlife, & Parks trails grant for avalanche education. Our plans for next season involve maintaining our current level of operation and serving our area users.

— Tony Willits

Montana: West Central Montana Forest Service Avalanche Center

Comparing precipitation data from the past two winters produces similar season end totals. On March 29th, 2002, we had 34.7 inches at the Stuart Mountain SNOTEL site. This year, on the same date, we had 31.6 inches. Also similar, we had a late start with a weak and shallow snowpack. At different times during the season, surface conditions produced weak, buried layers. Not surprisingly, undisturbed surface hoar buried by significant new snowfall was our most common instability scenario. Substantial snowfalls, heading into or during the weekend, resulted in at least 3 periods of increased instability. Snowmobilers and skiers reported a number of avalanche accidents during these times. Two separate accidents occurred involving multiple snowmobilers riding on the same slope at the same time. These two accidents involved a total of six riders being caught and / or buried. A number of skier and snowmobiler triggered slides that did not involve any burials or injuries were reported throughout the winter.

Educational efforts were well received this past season. The Avalanche Center responded to a variety of requests for avalanche awareness and education programs. Through cooperative efforts from non-profit and government agencies — the University of Montana Outdoor Program, the West Central Montana Avalanche Foundation, The West Central Montana FS Avalanche Center, and Kim Sayler of the Missoula Snowgoers Snowmobile Club — 1,392 backcountry users were able to learn about snow & avalanches. The total includes young students, adults, skiers, snowmobilers, snowboarders and snowshoers. Due to a decrease in funding from Montana Department of Fish, Wildlife and Parks, we presented fewer programs to school groups. However, on a positive note, we entered into a partnership with the City of Missoula Parks & Recreation Department and were able to tap into backcountry users that we had not previously been reaching. The City Parks & Rec promoted various winter recreation programs and included several of our avalanche awareness sessions and field days.

We posted fifteen weekend advisories which encompassed over 600 hotline calls, more than 11,600 web site hits and 315 faxes.

— Gene Thompson

New Hampshire: Mount Washington Avalanche Center

The 2002-03 season started early with our first general information advisory posted on October 28th. With consistent snowfall, we moved to daily forecasting on November

28th, issuing a total of 199 advisories in the seven-month season. After a great start to the snowpack in November, the storm tracks changed, taking most of the precipitation to southern New England. It was depressing for us to see all the big snowfalls going south. By the time January and February rolled around, we had an average snowpack, but the notable weather factor was the temperatures. We were in a cold snap with days at minus 20 degrees F becoming the norm. This made the ice climbing conditions very interesting with persistent ice dams and very brittle ice. We also got to experience a bit of a "western" snowpack with surface hoar development and faceting occurring. While this was exciting for us, we were more than happy to say goodbye to the cold temperatures. We were almost longing for the good old days of the "January thaw." March was a fairly dry month, with snowfall 27% below normal. April and May brought enough snow to get us back up to an average snowpack by the end of the season.

Unfortunately we started the season with a somber reminder that avalanches are deadly. The first avalanche accident occurred on November 29th when seven climbers were caught. Four of them were buried, with two of those killed. Two days later, four climbers were caught in another avalanche that resulted in two partial burials. One victim was severely injured while the other received minor injuries. The most disconcerting thing about this accident is that these four climbers helped with the rescue/recovery two days earlier yet still chose to venture into the ravine under Considerable avalanche danger and increasingly worse conditions. In February, two skiers narrowly missed becoming involved in a natural avalanche.

In addition to the avalanche accidents, we had about a dozen skiing and climbing accidents in the ravines this year. The Mount Washington Volunteer Ski Patrol (MWVSP), whose members are all Forest Service Volunteers, contributed 165 days (1,650 hours) helping visitors by giving out current safety information, responding to search and rescue events and caring for the injured.

Our snow rangers participated in the field portion of most of the fifteen avalanche classes held in our area, and some of the classroom portions as well. Over 300 people attended these courses. Cutler, our two-year old yellow Labrador, had good training opportunities through the winter and is coming along well. Our website —www.tuckerman.org — received over 175,000 visits (1.8 million hits to date!), and Cutler became a well-known celebrity.

When our season started, we were still short one snow ranger, so once again Brad Ray came back to help us out two days a week. He and Tuckerman (his German shepherd) worked with us from December through March. He helped show Justin, the newest member of the team, the ropes before we finally told him he could once again retire (we think!). Brad's love of the mountain still shines; he is now a patroller on the MWVSP! Justin Preisendorfer joined Chris, Brian and Marianne in March to complete the snow ranger crew. He has been a great addition to the team and brings a lot of local avalanche knowledge, technical rescue, and rock and ice climbing experience to the program.

The "Friends of Tuckerman Ravine" held their third annual "Son-of-Inferno" pentathlon (run-kayak-bike-hike-ski) in April to raise funds for the Avalanche Center. Once again they had a remarkable day for the race.

Though we had a sad start to the winter, the rest of the season was uneventful with the exception of the usual visitor mishaps and accidents. The die-hard skiers and riders continued to come to the ravine through June. We are looking forward to seeing them again next winter.

— Marianne Leberman

Utah: Forest Service Utah Avalanche Center:

The 2002-03 season was unprecedented in the modern history of Utah. Although significantly less snow fell than normal, more people unintentionally triggered avalanches in the backcountry than in any previous year. 176 incidents occurred that we know of, which smashed the old record of approximately 100. In those triggered avalanches, 65 people were caught, 16 were partially buried, six were totally buried, four were injured, and despite all this, there was only one fatality. These numbers include only the incidents we heard about, and we estimate that perhaps an equal number of people triggered avalanches that we did not hear about, especially among snowmobilers riding in rural areas outside of our forecast area. This list does not include explosive-triggered avalanches at ski resorts or on highways, nor does it include intentionally triggered avalanches in the backcountry, such as from ski cuts, kicking cornices or explosive stability testing by the helicopter or cat skiing companies. Skiers and snowboarders made up 94 percent of the incidents. Many fewer snowmobilers triggered avalanches this season than usual because it was a very dry, warm winter, and very little snow existed at low elevations —the terrain most often used by snowmobilers.

The avalanche incidents peaked during the three weeks from mid December through the first week of January, when Utah experienced the most active and continuous period of human triggered avalanches in our modern history. An incredible 68 unintentional human triggered avalanches occurred in the backcountry during this period, with 22 people caught. This averages three and a half incidents per day, and it continued nearly unabated for 20 days. Remarkably enough, no one died. A number of people—primarily skiers in the Salt Lake Area Mountains—got a good education in the persistent instabilities of faceted snow. The steady stream of very close calls included several deep burials followed by miraculous rescues using beacons and one beacon-less rescue of a completely buried person. You can find photos, stories and lists of avalanches and avalanche incidents on the web site at www.avalanche.org; click on Salt Lake.

The persistently unstable snowpack formed because of a severe snow drought in the first half of the season. November snowfall was 57 percent of normal at Alta, December 86 percent of normal and January was an incredible 27 percent of normal. By the end of January, we had the second lowest snowpack since record keeping began at Alta in 1944. Also, it was a very warm winter; the Salt Lake Airport came within 0.8 degrees F. from breaking the record for the warmest January on record. Very little low and mid elevation snow existed through most of the season, and the mountain ranges looked as Utah Avalanche Center forecaster Evelyn Lees described it in one of her advisories, "Like a birthday cake decorated by a child. They got frosting on top but forgot to frost the sides."

Ted Steiner, Executive Director Of Glacier Country Avalanche Center Inc, talking to a local TV News crew during the March, 2003, avalanche cycle that closed US Highway 2 and the Burlington Norther Santa Fe Railway for two days. Photo by Blase Reardon.

Although high elevation places like Alta ended up at 79 percent of normal, most mountain areas were between 50 and 70 percent, while Salt Lake City ended up with only 36 percent of normal snow for the winter. Maybe next year….

— Bruce Tremper

Utah: Forest Service Utah Avalanche Center Logan Office

The 2002-2003-winter season was dry and warm in the Bear River Mountains. As a result of these weather conditions, there were not too many avalanches reported to the Logan office of the Forest Service Utah Avalanche Forecast center. The Forest Service did not officially hire John Pagnucco, their new director/forecaster, until well after the first of the year. As a result, the Logan Center did not fully operate until February 11th. Before early February, only one report of natural avalanche activity in the Bear River Range was submitted the Forest Service Utah Avalanche Center in SLC.

Once the word got out that the Center was operational, observations started flowing into the office. It also started snowing. Starting February 15th and continuing until April 12th, I posted avalanche advisories for the Logan area backcountry at least every other day and later shifted to a regular Monday, Wednesday and Friday/Saturday morning advisory schedule.

A windy storm following the 15th caused a few natural avalanches to occur in the region. The avalanches that fell during the February 21-23 period were failing on an upper level weakness in the snowpack, just above a stout crust that formed around February 1st.

It wasn't until March 1st that the first human triggered avalanche of the season was reported to the Avalanche Center in Logan. There were several more human triggered avalanches reported in the following week, when a good shot of snow over five days coupled strong westerly winds. In the first week of March, Beaver Mountain reported 38 inches of snow, and the SNOTELsite at Tony Grove Lake reported an increase of slightly over 3 inches of water equivalence. The wind on Logan Peak during this time period registered many hours with average wind speeds of over 50 mph, with much higher gusts. On Saturday, March 8, in the Tony Grove Area, a snowmobiler was completely buried in an avalanche triggered by his companion. His party, all of whom carried avalanche rescue transceivers, shovels and probes, rescued him from a deep burial. Other snowmobilers in that area triggered several larger avalanches on the same day.

Through the rest of March and into April, springtime seasonal warming caused many natural, wet, surface snow avalanches in the Logan area backcountry. These point release avalanches were most common during the first significant warm-up after each storm.

Eucational programs were limited, due to my late hiring date. Several avalanche programs are scheduled for early this coming season, and I am planning a more extensive outreach program.

— John Pagnucco

Utah: Forest Service Utah Avalanche Center Moab Office

The season summary for the Moab office was unavailable this season.

Washington and Oregon: Pacific Northwest Avalanche Center

A slow start with a cool fast finish

The 2002-2003 season took some time to get started with October and November proving to be some of the driest on record for Seattle. Precipitation totals for these two month at Sea-Tac airport were a mere 45% of normal. With higher than normal freezing levels, this meant an even greater delay to any significant snowfall accumulations in the mountains. Hence the daily operational forecasting duties at the NWAC did not begin until December 14th, some three weeks later than average!

Snow finally arrived in earnest during the last two weeks of

December, and most areas approached normal snow depths by the end of December. Unfortunately, this was the period when the only avalanche-related fatality occurred in Washington. A dry and clear period in mid December produced widespread surface hoar. A very stormy period of heavy snowfall followed, with recorded wind speeds in many areas exceeding 100 MPH. This led to very sensitive slabs with buried surface hoar acting as the weakness. The fatality occurred near Crystal Mountain on December 29, when a party of seven skied increasingly steeper terrain and more wind loaded aspects. Investigations of this accident indicated buried surface hoar as the weak layer for this slide. The day before the accident, the ski patrol at Crystal Mountain Ski Area experienced sympathetic releases while approaching slopes, with some slabs propagating uphill into terrain with slopes angles of about 20 degrees!

January began with a good snowstorm that changed to rain a few days later as freezing levels climbed. While this produced widespread avalanches, no fatalities occurred. One close call occurred on New Years Day above the Paradise visitor center on Mt Rainier. Two snowshoers on a trail triggered and were caught by a 2 to 4 foot slab. The slide totally buried one and buried the other with exception of one hand. Witnesses helped to uncover the one partially exposed person using snowshoes as shovels, and they were then able to find and uncover the buried party member with no injuries sustained. For this couple there turned out to be much to celebrate on New Years Day 2003!

A return to a blocking ridge of high pressure induced mostly dry and mild conditions for nearly the rest of January. Freezing levels averaged about 8000 feet for January and climbed to 12,000 feet twice. For those from the Rockies, think of these elevations as being equivalent to 20,000 foot freezing levels in the middle of winter! Needless to say, strong surface crusts developed on the snowpack. The last week of January saw heavy rain at high freezing levels as the ridge was replaced by a strong, wet southwest flow. This wet weather produced initial avalanches but drain channels developed rapidly to disperse the three to five inches of rain that fell over most west slope areas of the Cascades and Olympics.

February saw a return to dry and mild conditions with average freezing levels of about 8000 feet for the first half of February. These conditions again produced a strong surface crust in the Pacific Northwest snowpack. March followed as the snowiest month of the year, with nearly two times the normal water for the month falling. Our climate snow depth averages rebounded to near normal levels for most stations. Warming and rain did return at the end of March and this produced our first spring slide cycle. Another close call occurred on March 29th when a lone skier on Granite Mountain near Snoqualmie Pass either triggered or was caught by a wet snow avalanche. He was seriously injured and found by a hiker who initiated the rescue operation with the victim subsequently being air-lifted to Harborview Medical in Seattle.

April seemed relatively normal in the Northwest, meaning cooler than average and steady snow. This cool snowy period continued March's trend in edging snow depths up towards normal, especially at mid and higher elevations sites.

The cool showery weather continued through May as one upper level low pressure center replaced another over the Pacific Northwest. This maintained low freezing levels with periodic new snowfall. While ski areas in the region had finished the season, the WSDOT avalanche crews remained quite busy inducing very large avalanches above Chinook Pass in the central Washington Cascades before it opened for public travel on May 22nd. The warm weather of spring finally arrived leading into the Memorial Day weekend with freezing levels near 13,000 feet and mountain temperatures climbing into the 60's and even low 70's. With the overall cool spring with periodic new snowfall, the snowpack was slower to stabilize and convert to more typical spring-like conditions. Therefore, we issued a special statement prior to the weekend to cover the potential of some larger wet snow avalanches accompanying the first very warm period of the spring.

Office, Instrumentation and Other News:

The web is still going strong, thanks to Al's keen foresight. The NWAC is on pace for 2 million web accesses of our forecasts and station data, up another 20% over last year, which was itself up 45% from the year before. This increase may in part be due to recent changes that have made for a more efficient and reliable instrumentation network. As the NWAC moves towards breaking up stations formerly served by only one micrologger into numerous sub stations with separate loggers, we have produced a more reliable system. Why didn't we think of this before? Years of long and troublesome land line problems probably kept us from thinking properly about a more long-term solution. In addition, we have left our convoluted and undocumented DOS based system of data retrieval and have turned to a more reliable and understandable Campbell Scientific solution. We are still slowly working towards and looking forward to a shift away from text-based display to a modernized graphical display of our data in the future. . .baby steps.

The Friends of the Northwest Avalanche Center (FOAC) held several strongly supported events throughout the year, beginning in the fall with the annual SnowBash 2003 that raised the roof and a fair bit of cash to help with the center's continual budget woes. Additional events included film festivals, the Teton Gravity Research annual show and a visiting program from the Telluride Mountain Film Festival…both very successful. At this writing, we are preparing for another annual cooperator meeting in hopes the majority of our current cooperators wish to remain so. We are exiting the 2002-03 season faced with our biggest projected budget deficit to date, about $54,000 short or nearly 20% of our overall budget. Not to worry, summer is here regardless, and we'll find plenty of ways to enjoy it before coming back to meet next seasons challenges. Wishing you all a great "off" season.

— Kenny Kramer

Wyoming: Bridger-Teton National Forest Avalanche Center

The Center received reports of a total of 19 backcountry avalanche events with significant human involvement were reported to the Center this season. Six of the 24 people caught died. One victim had a transceiver but was alone, three were buried without transceivers, one died of trauma on the snow surface, and one was buried with a transceiver but damage to his partner's transceiver delayed his recovery. There were five full burials of victims wearing transceivers who were successfully recovered, five partial burials and five injuries.

During the past three seasons, 15 fatalities have occurred in our forecast area. Ten of these fatalities occurred in Teton County, Wyoming. The average age of the Teton County victims was 31.3 years. Nine were male. Four were alone. Seven were in the southern Teton Range less that an hour from a trailhead. Cliffs, very long drops or terrain traps were a factor in seven of these 10 incidents. Most victims died during considerable hazard. These statistics don't take into account the thousands who went and returned safely yet are indicative of the risks people seem to be willing to take.

The season began on November 10th, when snowfall buried faceted snow that had formed on October crusts. In separate incidents, two backcountry skiers were buried except for a short portion of their skis. Companions quickly rescued the victims during stormy conditions.

Another layer of faceted snow on crust plagued backcountry users from mid December to late January. A warm, wet storm cycle finally bridged over this active bed surface. For several weeks conditions were extremely fragile. Numerous dangerous slides were triggered on approach. Users escaped injury partially because slopes would fail before they could get onto them.

Conditions changed on the afternoon of January 3rd, when strong winds increased the density of the snow surface. After the 3rd, soft slabs, which had been easily triggered from a distance, were now able to bear the weight of humans. A rash of accidents occurred. On January 4th a snow boarder died from trauma after he triggered a big slab on his second run near Ski Lake. On the same day a snowmobiler broke a femur in a slide in Darby Canyon. The next day a 16 year-old snowmobiler died in an avalanche in the Salt River Range. He was the third rider to cross the slope. Two snowboarders were partially buried on the 7th near Grand Targhee Resort and a snowmobiler caught in a large slide on the 8th in the Snake River Range deployed an inflation system and escaped. The final incident on this bed surface occurred on January 25th when a snowmobiler ignored the warnings of his guide and died in the Kettle Creek drainage.

A lone snowboarder died in a slide in Avalanche Bowl in late January. On February 9th a backcountry skier was completely buried in a terrain trap and was quickly recovered by companions. On the 10th an alpine skier died in an avalanche in a permanently closed area of the Jackson Hole Mountain Resort. The final fatality of the season occurred in the Salt River Range on February 24th. The victim, a snowmobiler, was the only member of his party without a transceiver. On March 13th one snowmobiler was injured and another uncovered from a depth of eight feet in an avalanche in the Salt River Range.

It took all season and a very wet March to attain the near average snow depths observed in early April. There were 732 avalanches reported to the center. Of these, 266 were in the backcountry, and 466 were at the Jackson Hole Mountain Resort. In the backcountry, there were 149 natural avalanches, 105 human triggered avalanches and 12 explosively triggered avalanches (highway and helicopter operations). There were only 9 natural avalanches in the resort after avalanche hazard reduction efforts had begun. Most of the slides triggered in the resort were small and the backcountry events were generally larger.

We installed three new remote weather stations in October. The equipment for these stations was purchased and installed as Phase II of a grant obtained in partnership with the Wyoming Trails Program. Five automated stations were installed last season. Seven manual stations to be installed this summer will complete the final phase of this project.

A research project with Inter-Mountain Laboratories (IML) of Sheridan, Wyoming was very successful. This effort has determined that avalanches make a distinct infrasonic sound that can be remotely detected. IML has obtained two new grants for next season. A National Science Foundation grant will research the ability of an array of sensors to detect the location and magnitude of avalanches in real time. A Wyoming Department of Transportation grant will research the feasibility of using infrasonic sensors in a highway setting on Teton Pass.

Jim Springer spent the season on exchange for the resort in Tiennes, France. We look forward to his return and our chance to go on exchange. Jim Farmer, Mike Rheam and Chris McCollister stepped up to the plate while Jim was in France. Mike spearheaded education efforts including an awesome snowmobile field day at the Crooked Creek Guest Ranch. Chris McCollister and Kendall Comey completed programming that collects and summarizes the data from our weather stations and uploads it into our daily web advisories and historical record. Chris also helped developed a digital avalanche atlas with links to our historical database.

— Bob Comey

Backcountry skier Susi Hauser examines the bed surface of an avalanche her party triggered from a completely flat part of the ridge about 50 feet away. Another New Year's Day human triggered avalanche, this time in West Monitor Bowl, Wasatch Range, Utah. Photo by Bruce Tremper, U.S. Forest Service Utah Avalanche Center.

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