THE Avalanche REVIEW

A Publication of the American Avalanche Association®

VOLUME 33, NO. 1 • SEPTEMBER 2014

www.AmericanAvalancheAssociation.org

2013/2014 SEASON ROUND-UP

Photo by Jason Skipper, from an overnight on Silver Peak.

Photo by Tighe Stoyanoff

Granite Mountain Avalanche: *Text from NWAC report by Dennis D'Amico, Avalanche Meteorologist, USFS Northwest Avalanche Center, Seattle WA.*

Late Saturday afternoon during the first weekend in spring two skiers and a dog descending the looker's left or west avalanche path on the south side of Granite Mt (visible from I-90) were involved in a slab avalanche that sympathetically triggered a second slab avalanche closer to the ridgeline. During the week prior to the accident in March, two separate storms affected the area; the first brought 14 inches of snow through Monday morning the 17th, the other 16 inches by early Thursday morning of the 20th measured at the NWAC station at the top of Alpental (roughly 5500 feet). The slope involved would have been wind loaded from the previous storms.

After reviewing the avalanche photos and talking with local Snoqualmie area avalanche professionals, we believe that the bonds between the most recent storm layers were weakened by strong solar input Saturday, creating potential melt water in the upper snowpack during the afternoon hours on the slope that released. The avalanche characteristics detailed above were gathered from three different local avalanche professionals on-scene following the avalanche. What began as a slab avalanche ended up as a powerful wet loose at lower elevations. We don't believe the upper snowpack structure that led to this accident was common throughout the west slopes of the Cascades during this time period. Similar slab avalanches, either natural or human triggered, were not reported prior to or after this accident in the area. The avalanche forecast was updated early Sunday morning to include details of the accident; however, the avalanche danger rating was not changed from Moderate for the Snoqualmie Pass area. Tragically, this is the same path where a climber triggered an avalanche, resulting in a fatality in mid-April of 2013.

The Avalanche Review
P.O. Box 248
Victor, ID 83455

To read more about the Granite Mountain avalanche, see the NWAC season summary on page 18.

in this issue

THE Avalanche REVIEW

SEPTEMBER 2014 • VOL. 33 • NUMBER 1

The Avalanche Review is published each fall through spring by the American Avalanche Association, Inc., a nonprofit corporation. ***The Avalanche Review*** welcomes the submission of articles, photographs and illustrations.

Please send submissions to:
Lynne Wolfe — Editor
PO Box 1135
Driggs, Idaho 83422
tel: (208) 709-4073
lwolfe.avalanchereview@gmail.com

Advertising:
Paul Nordquist
1101 Lenore Drive
Tacoma, WA 98406
tel: (253) 830-4444
pwnordquist@gmail.com

Production:
McKenzie Long
PO Box 9368
Mammoth Lakes, CA 93546
tel: (513) 515-0723
mckenzie@cardinalinnovative.com

Business and Subscription Office:
Jaime Musnicki — AAA Executive Director
PO Box 248
Victor, ID 83455
tel: (307) 699-2049
aaa.jaimem@gmail.com
aaa@avalanche.org

american avalanche association AAA

The mission of the AAA is:

A. To provide information about snow and avalanches;

B. To represent the professional interests of the United States avalanche community;

C. To contribute toward high standards of professional competence and ethics for persons engaged in avalanche activities;

D. To exchange technical information and maintain communications among persons engaged in avalanche activities;

E. To provide direction for, promote, and support avalanche education in the US;

F. To promote research and development in avalanche safety.

Subscription: $30 per year (4 issues). Subscription is included with membership dues to AAA. For subscription and membership information, see **www.AmericanAvalancheAssociation.org**.

Contributions: Please submit material eight weeks prior to publication date. Include address and telephone number. Please submit typed manuscripts by e-mail or disk (CD or DVD), using any popular word processing program. Submit any figures as an EPS (preferred), PDF, TIFF or JPG 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.

Layout & Design: McKenzie Long, Cardinal Innovative, (513) 515-0723, mckenzie@cardinalinnovative.com.

from the executive director

Hello from the AAA,

Photo of Jaime and Telly by Gail Musnicki

Boy, is summer flying by! I am not quite ready to let the warm, sunny days go, though I recognize snow will be flying again before I know it. I'm hoping for some extended summer weather into September and maybe even October here in the Tetons. We shall see how this transition goes this year.

At the AAA, winter never seems that far away as we continue thinking about and working on projects related to snow and avalanches all year long. This summer, amongst other less-glamorous administrative tasks, I have spent time distributing funds for regional Professional Development Workshops during the 2014/15 season. These grants are made possible by a generous annual donation from CIL Explosives. Find dates and locations published in this issue of TAR for an event near you.

Another major project at the AAA right now is revising the framework of avalanche education in the U.S. In collaboration with a number of the current professional level (L3, NAS, AVPro) course providers in the country, the AAA has been leading the process of evaluating the need to restructure our system and mapping out a plan to do so. The AAA and the core group of course provider stakeholders so far agree that a system that differentiates between the avalanche education needs of professionals and recreationists will better serve both of these user groups. This working group plans to have a draft proposal on the revised paradigm to distribute to members and a broader segment of stakeholders by ISSW this fall. Keep an eye out for continuing developments here and opportunities to provide your thoughts and input in the process. This system-wide revamp will only be effective for avalanche education "consumers" (all of us, really) if a broad scope of professionals is on board with the reasoning and direction of the project. The current implementation timeline of the project is two to three years; we want to ensure that we effectively and thoroughly build support and create a well-thought-out system that will serve the industry for many years to come.

In closing, some reflections on transitions and tipping points… It feels to me that the AAA and the avalanche industry are at the edge of something potentially BIG right now. The above-mentioned avalanche education project is just one example of the potential for significant change in our industry. Times of transition are exciting: they hold great potential for creating major positive shifts in our world, which can feel scary as they rock the status quo and ask us to step into the unknown. There is certainly risk involved with potential positive and negative consequences. My goal is to help lead the AAA into the fray of this transition and out the other side as a stronger, more relevant organization that even better represents the needs of our industry. When you have a chance, let me know your thoughts on this. I hope people's summers have gone well and look forward to meeting many of you at ISSW in Banff very soon.

—Jaime Musnicki, Executive Director

from the editor

Snow on the high peaks, green valleys become gold, then white.

March powder skiing at the Plummer yurt. *Photo by Jane Gallie*

It's been a summer of transition for me. When my husband Dan had a nasty bike accident at the end of July, I chose to take a hiatus from summer guiding to help him recover. He's riding his bike to physical therapy now, a good indicator of his recovery, and should be on skis no problem. For me, that hiatus may stretch to retirement from rock guiding (after 26 years, I have plenty of Grand Teton ascents to lean back on), or it may not. I may pursue a second (or would it be third or fourth?) career in mountain bike advocacy and guiding, or into more writing and publishing work.

I'll be pondering these directions throughout the winter, but in the meantime will stay loyal and invested in the snow and avalanche world.

We're on the 33rd year for The Avalanche Review; the 13th for me at TAR. I am proud of what we have accomplished in the last 13 years, the first five with Blase Reardon at the helm or as co-editor; the last eight as sole editor. We've gone to color thanks to Blase, we've instigated a system of themes from issue to issue, and now we are working with a new graphic designer, McKenzie Long, who has some great ideas that she can't wait to unroll for us.

Themes for this upcoming volume include but are not limited to: December TAR- looking at urban avalanches, with input from Steve Karkanen of Missoula, Tom Mattice of Juneau, Janet Kellam of Ketchum, and professional perspective from Art Mears and Chris Wilbur of Colorado. Let me know if you have insight or questions or a particular avalanche problem that applies here.

The February TAR usually has some kind of science-based theme. I'll be paying attention at ISSW in Banff, looking for theory and tools that help us understand our world and make better decisions. Help me out with this, folks, please. What's important to you? What should appear in the science issue? Skier triggering? Efficacy of explosives? Rescue updates? Let me know.

For the last few years, the theme of the April TAR has revolved around decision-making, human factors, and case studies. There's a lot of brain power and research going into these topics right now, bringing material into the avalanche world from other areas of study; I find myself endlessly curious and interested. How about you?

The Avalanche Review welcomes your photos, submissions, questions, letters to the editor, commentary, and compliments.

Deadlines for submissions are as follows:

December TAR, 33-2: October 15
February TAR, 33-3: December 15
April TAR, 33-4: February 15

Thank you,

—Lynne Wolfe, Editor

Congratulations and thanks to the following new AAA Members for 2014:

Professional Members:
Gordon Scott - Girdwood, AK
Graham Predeger – Anchorage, AK
Lauren Georgelos – Girdwood, AK
Al Mandell – Minot, ME
Mark Renson – Hudson, MA
Alex Marienthal – Bozeman, MT
Danielle Monique Roy – Bozeman, MT
Derek Lennon – Big Sky, MT
Isaac Fleming – Bozeman, MT
Lloyd Morsett – Whitefish, MT
Mark Rickbeil – Billings, MT
Nicholas VanHorn – Bozeman, MT
Scott Dreblow – Bozeman, MT
Tom Eddy – Sandpoint, ID
Brandon Everett – Clearfield, UT
Brett Korpela – Sandy, UT
Brian Muller – Salt Lake City, UT
Bryan Biggs – Boise, ID
David Kelly – Salt Lake City, UT
Frank Waikart – Riverdale, UT
Jaime Musnicki – Victor, ID
Jamie Weeks – Jackson, WY
Jimmy Tart – Heber, UT
Kory Davis – Ogden, UT
Marc Hanselman – Ketchum, ID
Nancy Bockino – Moose, WY
Scott Bedford – Hillsborough, CA
Bryan Hendrick – Redmond, WA
Jeff Ward – Leavenworth, WA
Julian Hanna – Portland, OR
Paul Knippel – Bellingham, WA
Shane Robinson – Seattle, WA
Thomas Guthrie – Seaside, OR
Tod Bloxham – Tacoma, WA
Victor McNeil – Banks, OR
Wyatt Southworth-Thomas – Seattle, WA
Andrew Kiefer – Durango, CO
Chris Myall – Crested Butte, CO
Cody Perry – Steamboat Springs, CO
Dave Ahrens – Ouray, CO
Eric Haskell – Avon, CO
Gary Osteen – Steamboat Springs, CO
Jack Norton – Silverthorne, CO
Janine Prout – Salida, CO
Jeffrey Davis – Frisco, CO
Jess Wegert – Silverton, CO
Maria Tucholke – Red Cliff, CO
Mark Hammond – Eldorado Springs, CO
Maureen Fox – Woody Creek, CO
Michael Russo – Dillon, CO
Mike Lewis – Leadville, CO
Nick Barlow – Evergreen, CO
Peter Walker – Ophir, CO
Reed Ryan – Dillon, CO
Roger Coit – Salida, CO
Sarah Janin – Avon, CO
Sheldon Kerr – Silverton, CO
Dane Brinkley – Mount Shasta, CA
Neil Satterfield – June Lake, CA
Pedro Rodriguez – Berkeley, CA
Johann Slam – Stewart, BC
John Tweedy – Castlegar, BC
Mike Bromberg – Revelstoke, BC

Member Affiliates:
Sean Fallon – Girdwood, AK
James Cyrs III – Sugar Hill, NH
Dustin Dearborn – Jeffersonville, VT
Elizabeth Fricke – Missoula, MT
Terry O'Connor – Ketchum, ID
Erin Merrick – Salt Lake City, UT
Scott House – Heber City, UT
Paul Rachele – Jackson, WY
Kate Koons – Victor, ID
Michael Henderson – Ogden, UT
Niels Meyer – Hailey, ID
Daniel Turner – Ogden, UT
Peter Ginsbury – Jackson, WY
Russell Milholland – Alta, UT
Timothy Matthews – Park City, UT
Matt Jensen – Seattle, WA
Daniel McGarry – Seattle, WA
Stephen Showalter – Puyallup, WA
Brian Flynn – Seattle, WA
Jonathan Cromwell – Langley, WA
CJ Svela – Bend, OR
David Walker – Duvall, WA
Dale Wang – Eldorado Spring, CO
Alison Sheets – Eldorado Springs, CO
Hans Flinch – Denver, CO
Dan Edmiston – Steamboat Springs, CO
Thomas White – Denver, CO
Uwe Sartori – Littleton, CO
Joe Messina – Steamboat Springs, CO
Jeff Dobronyi – Telluride, CO
Michael Phillips – Mammoth Lakes, CA
Pierson Bourquin – San Francisco, CA
David Miller – Tahoe City, CA
Jacob Swartz – Truckee, CA
Robin McElroy – Tahoe City, CA
Matthew Komatsu – Anchorage, AK
Corrina Marote – Stanwood, WA
Ryan Johnson – Kodiak, AK

grants

Theo Meiners Avalanche Research Grants

In honor of Theo Meiners' tireless efforts to support avalanche research prior to his passing in the fall of 2012, funding is available to support avalanche research projects. The International Snow Science Workshop 2012 has teamed with John Byrne III, the owner of Alyeska Resort, to offer two separate grants of $2,500 each during the fall of 2014, These funds will be administered by the American Avalanche Association grants process.

Applications for the research grants must be submitted by Sept. 30, 2014 with the awards being disseminated by October 31, 2014.

One of the two grants, the "research" grant, can be applied to basic research projects in avalanche behavior or modeling. The other "practical" grant will be awarded to a practitioner project with an emphasis on a subject that would be relevant to helicopter skiing.

Applicants should describe their proposed project, identify the need for grant funding as well as where the funding would be applied, and present a proposed timeline. All grant recipients will be required to submit a paper for presentation at the International Snow Science Workshop. Grant recipients in 2014 will be required to submit a paper for ISSW Breckenridge in 2016.

Inquiries about the grants and appropriate projects can be directed to David Hamre at hamred@akrr.com or 907-223-9590.

Applications can be submitted by downloading the form and emailing your application to the Chair of the AAA Research Committee (Jordy Hendrikx: jordy.hendrikx@montana.edu).

For more information: americanavalancheassociation.org/grants_research.php

The AAA Research Committee would like to remind members of the **upcoming call for Graduate Student Research Grants** and the new extedended deadline for the Practitioner Research Grants. **The deadline is September 30, 2014.**

The American Avalanche Association awards seperate research grants to avalanche field practitioners and graduate students conducting active research on snow avalanches. For more information and application forms, please go to our research homepage: www.americanavalancheassociation.org/grants_research.php or contact Jordy Hendrikx (jordy.hendrikx@montana.edu) for any questions.

Calling all avalanche dog handlers!

Avalanche dog Tatanka digs in for a find. *Photo by Eeva Latosuo*

In spring 2014, we started a pilot study to learn more about the effects of surface contaminants such as tree debris and gasoline fumes on avalanche dogs' scenting ability. We developed a methodology by observing Alyeska Ski Resort operational dogs go through series of experiments. Now we would like to expand this research to collect data from a larger number of operational dogs throughout United States and Canada.

In addition to this research, we are creating a public database to provide a complete list of search and rescue dog organizations, specifically avalanche search and rescue dogs. The database would allow the centralized access to information about the dog organizations, geographic location, history, list of validated teams, and validation standards within the U.S. If you and/or your affiliated search and rescue dog organization would like to participate in this research study or have resources or knowledge that would contribute to the database, please contact Molly Schouweiler (mschouweiler@alaskapacific.edu) or Eeva Latosuo (elatosuo@alaskapacific.edu.) Any questions? Email us or stop by at our ISSW poster presentation on Friday, October 3, from 11:40-13:25 at the Kinnear Centre, room 303/305.

—Eeva Latosuo and Molly Schouweiler, Alaska Pacific Universityr

metamorphism

New TAR graphic designer—The Avalanche Review is thrilled to introduce our new graphic designer, **McKenzie Long**, of Mammoth Lakes, CA. She comes to us with a strong resumé in graphic design, having worked on the layout for multiple publications with the guidebook publishers Wolverine Publishing and SuperTopo, in addition to work for clients such as The American Alpine Club and Cloudveil. We look forward to working with McKenzie. She can be reached at (513) 515-0723 or mckenzie@cardinalinnovative.com.

Gallatin Pro Development Workshop

April 2, 2014

I had the pleasure of attending the Professional Development Workshop put on by the Gallatin NF Avalanche Center up in Bozeman, MT this spring. Just back from a week down in the desert of southern Utah, it was fun and engaging to re-immerse myself in the world of snow and avalanches for a full day of learning from a slew of talented and passionate snow scientists. More than 50 people attended the event, which was held at the Bozeman Public Library. Snow science was the theme of the day; Bruce Jamieson was the speaker of the day, providing four different presentations throughout the workshop.

The morning's flow warmed us up with a few presentations on snowpack tests before delving deeper into more technical aspects of slab fracture and snow structure. Bruce started off by sharing his perspectives on what snowpack tests are best when, noting limitations and strengths of both the ECT and PST. Karl Birkeland followed with a presentation looking at whether CT results vary with slope angle; his preliminary findings, which he plans to bolster with more data this coming winter, seem to show CT results remaining consistent with changing slope angle.

We then heard from GNFAC forecaster Eric Knoff about his experimentation with a horizontal PST format, which on lower angle slopes is showing similar results in a given pit to the traditional PST orientated in line with the fall line. Next, MSU grad student, Ian Hoyer, shared some preliminary findings of his current research (funded in part by a Research Grant from the AAA) on spatial variability of fracture propagation and the effectiveness of the ECT. Then Karl returned for a second morning presentation, this time looking at how a number of different factors in weak layers and slabs can affect fracture; this presentation provided some well-timed comic relief and an amazing visual that featured silo destruction somewhere in the heartland of the U.S. Ron Simenhois was next on the morning's docket with a presentation on how HARD it is to forecast the release of glide avalanches that included some impressive time lapse photography as a tool for closer study of this phenomenon. Perhaps the most energetic presenter of the day, Ed Adams talked to us and showed us some cool photos of snow crystal microstructure taken in his lab at MSU. Finally, book-ending the morning before a break for lunch, Bruce returned to the stage to explain how different types of travellers stress the snowpack differently.

While I thought it potentially impossible to further cram my brain with interesting thoughts and research about snow, after lunch we did just that. Alex Marienthal (another AAA Research Grant recipient) lead the charge in the toughest slot of the day, bringing us back to life post-lunch with a look at deep slabs failing on persistent weak layers out at Bridger Bowl. Bruce then took us up to the Columbia Mountains of interior British Columbia to talk further about the lurking deep slab and the myriad challenges of forecasting for this beast. Around mid-afternoon we took a moment away from the "hard" snow science to hear from social scientist Jerry Johnson of Univ. of Montana on his current project studying skier behavior, group dynamics, and decision-making using an app that tracks you/your party throughout your tour. Dan Miller then presented on his work that examines microstructure of snow- when and where fracture initiates. To wrap up the day, Bruce graced us with one more presentation, this time sharing case studies of solar-induced avalanches.

Following closing remarks from Doug Chabot, folks filtered over to the Ale House, conveniently located just across the street, to share in more informal snow, avalanche and life conversations and enjoy some cold brews. At the end of the day I was impressed by the high caliber of presentations (a lot like a mini-ISSW for the day) and appreciative of all the efforts of the GNFAC folks for organizing and hosting such a worthwhile event. This event, and seven other pro development workshops across the country during the 2013/14 season, was supported by the AAA through a generous gift from CIL Explosives.

—Jaime Musnicki, AAA Executive Director ❄

New Hires in the Avalanche Industry

The National Avalanche Foundation has named **Janet Kellam** as Program Director of the National Avalanche School for 2015-2016. Janet continues as chair of the NAS Instructor's Steering Committee, has been an NAS instructor since 1999 and works with NAS Program Coordinator Jennifer Larson. The National Avalanche School utilizes many of the industry's leading experts and offers comprehensive professional training for ski patrollers, avalanche forecasters and mitigation specialists, mountain managers as well as Forest Service, National Park Service and other land management personnel.The next National Avalanche School will be held at Snowbird, UT, October 25-29, 2015. www.avalancheschool.org

Photo by Blase Reardon

The Forest Service National Avalanche Center (NAC) is pleased to announce the addition of **Simon Trautman** to our staff. Simon has a broad range of avalanche experience, including snow safety work at Moonlight Basin Ski Area, avalanche forecasting at both the Colorado Avalanche Information Center and the Sawtooth National Forest Avalanche Center (SNFAC) and, most recently, as the Director of the SNFAC. In addition to his practical experience, Simon completed his MS degree in Earth Sciences at Montana State University doing research on wet snow avalanches. At the NAC Simon will work on everything related to the Forest Service avalanche program, including providing program support to the avalanche centers, assisting with the military artillery program, and providing expertise and support on a variety of avalanche issues to Forest Service personnel agency-wide. Simon's hiring brings the NAC staffing back up to two permanent employees for the first time since the retirement of the late Doug Abromeit a little over three years ago, and is welcome news for NAC Director Karl Birkeland!

From **Max Forgensi**:
The last year has been a bit crazy…hopefully by the time the snow sticks in the high country, I will have my feet under me once again.

I am the Mountain Sports Permit Administrator for Vail/Beaver Creek Resorts while additionally overseeing the recreation special uses program on the Eagle/Holy Cross Ranger District. My primary job is to work in partnership with the resorts administer and develop world-class recreation to visitors in both winter and summer. This includes working on expansion proposals, chairlift upgrades, mountain bike trail development and being a part of the 2015 World Ski Championships at Beaver Creek. Just a little different from being an UAC forecaster in Moab.

So far it's challenging and I am enjoying the job! ❄

Pro Development Workshop Schedule

- **Northern Rockies Avalanche Safety Workshop**
  Whitefish, MT – October 25
- **Southeast Alaska Snow & Avalanche Workshop**
  Juneau, AK – November 1
- **Utah Snow & Avalanche Workshop**
  Sandy, UT – November 1
- **Southcentral Alaska Avalanche Workshop**
  Anchorage, AK – November 7
- **Eastern Snow & Avalanche Workshop**
  North Conway, NH – November 8
- **Northwest Snow & Avalanche Workshop**
  Seattle, WA – November 2
- **Colorado Snow & Avalanche Workshop**
  Breckenridge, CO at the River Walk Center – October 17
- **Sierra Avalanche Center Pro Development Workshop**
  Lake Tahoe, CA – April 2015
- **Sawtooth Pro Development Workshop**
  Stanley, ID – Spring 2015
- **Gallatin Pro Development Workshop**
  Bozeman, MT – Spring 2015

For more information on these seminars, go to www.americanavalancheassociation.org

what's new

AvaTech: Q&A with The Avalanche Review

Who we are / Why we are:

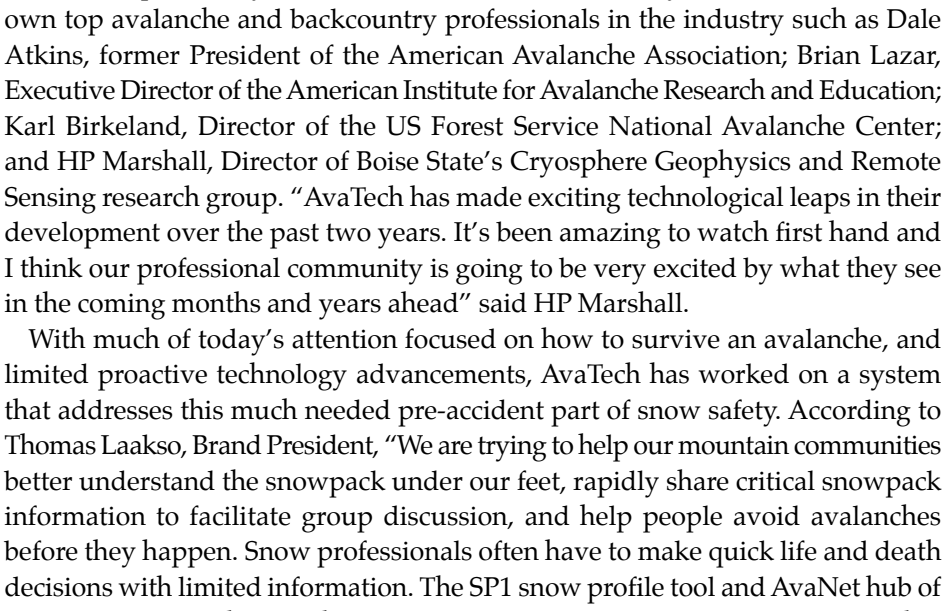
In 2010, Brint Markle's friend was nearly killed in an avalanche in Switzerland. The pair were skiing different routes down the backside of Mont Fort. Markle's friend was caught and carried several hundred yards, nearly pushed over a set of cliffs. "It was a classic example of ability over education," Markle said. "We had more abilities than knowledge of the snow and avalanche safety. It was a bluebird day. Lots of powder. And we said 'Let's go for it.' That was not only a wakeup call, but also got me thinking about what happened that day, what went wrong, why we made the decisions we made, and whether there could be anything out there that could prevent something like that from happening," explains Markle. Today, Markle is the CEO of a start-up out of MIT called AvaTech. AvaTech builds proactive systems that instantly analyze the snowpack and facilitate the sharing of this information real-time in order for individuals and groups to make better decisions. Their first products include the SP1, a high precision, portable, lightweight, and web-connected penetrometer that measures snow structure and other critical snowpack information, AvaNet, a global snowpack data platform that crowdsources information from the SP1, and a new easy-to-use drag and drop manual snow profile tool that has potential to become a new industry standard. Started in 2012 in Cambridge and now headquartered in Utah, they are debuting their new technologies at the International Snow Science Workshop in Banff in late September.

Over the past two years AvaTech has built an advisory board of some of our own top avalanche and backcountry professionals in the industry such as Dale Atkins, former President of the American Avalanche Association; Brian Lazar, Executive Director of the American Institute for Avalanche Research and Education; Karl Birkeland, Director of the US Forest Service National Avalanche Center; and HP Marshall, Director of Boise State's Cryosphere Geophysics and Remote Sensing research group. "AvaTech has made exciting technological leaps in their development over the past two years. It's been amazing to watch first hand and I think our professional community is going to be very excited by what they see in the coming months and years ahead" said HP Marshall.

With much of today's attention focused on how to survive an avalanche, and limited proactive technology advancements, AvaTech has worked on a system that addresses this much needed pre-accident part of snow safety. According to Thomas Laakso, Brand President, "We are trying to help our mountain communities better understand the snowpack under our feet, rapidly share critical snowpack information to facilitate group discussion, and help people avoid avalanches before they happen. Snow professionals often have to make quick life and death decisions with limited information. The SP1 snow profile tool and AvaNet hub of real-time data will help gather more objective, repeatable and accurate data that can support more informed decision making."

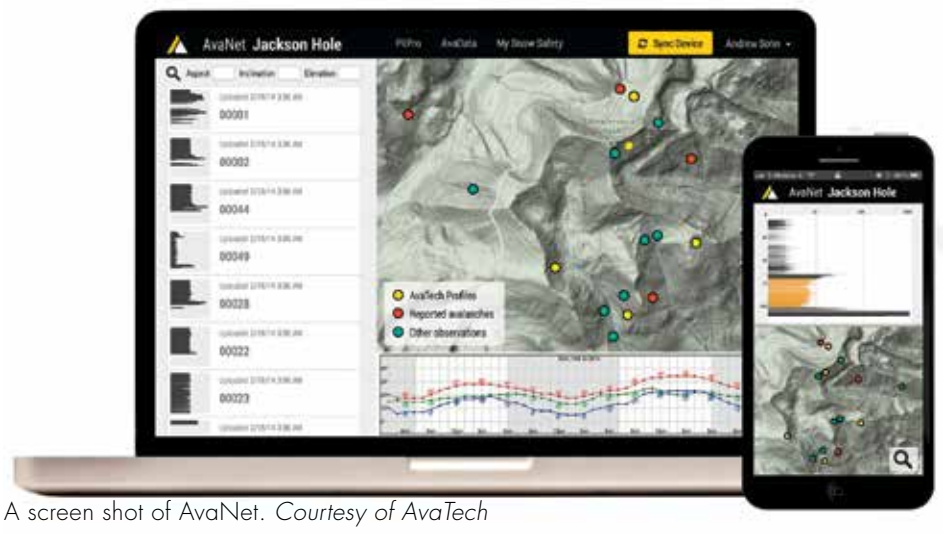
How do the SP1 and AvaNet work?

The SP1 leverages a variety of state of the art sensing technologies to help users gather and share rapid, objective information about the snowpack. SP1 geotagged measurement data is automatically synched via bluetooth to a smartphone application and the cloud, creating a unique crowd-sourced database of snow conditions from avalanche-prone areas. The SP1 provides a high resolution read out of snow structure which can easily be linked to slope angle, aspect, and GPS location. The device helps professionals monitor and track specific weak layers in the snowpack, speed up the data collection process, share information more easily among the community, and potentially improve the accuracy and objectivity of snowpack evaluation. This is the feature that I referred to on the phone. "Every so often, new technology comes along in an industry that's not step change, but orders of magnitude. We're seeing this with AvaTech today in our industry" states Jordy Hendrikx, professor of snow science at Montana State University.



Brand advisor Chris Davenport beta testing the SP Pro technology from AvaTech last winter on Mt St Elias. *Courtesy of AvaTech*

Sharing data across a broad network has the potential to create one of the largest sets of snowpack information in the world. Currently it is mainly focused on helping to streamline forecasting methods and improve the understanding of spatial variability for the professional community. The database will enable improved day-to-day reporting; historical analysis by being able to look at how zones change through the season; and event diagnostics, which will provide a comprehensive,



A screen shot of AvaNet. *Courtesy of AvaTech*

technology-based platform for proactive avalanche safety. Users are encouraged to share this information broadly, but also have the option to share their data only within a defined group, such as a ski area snow safety management operation.

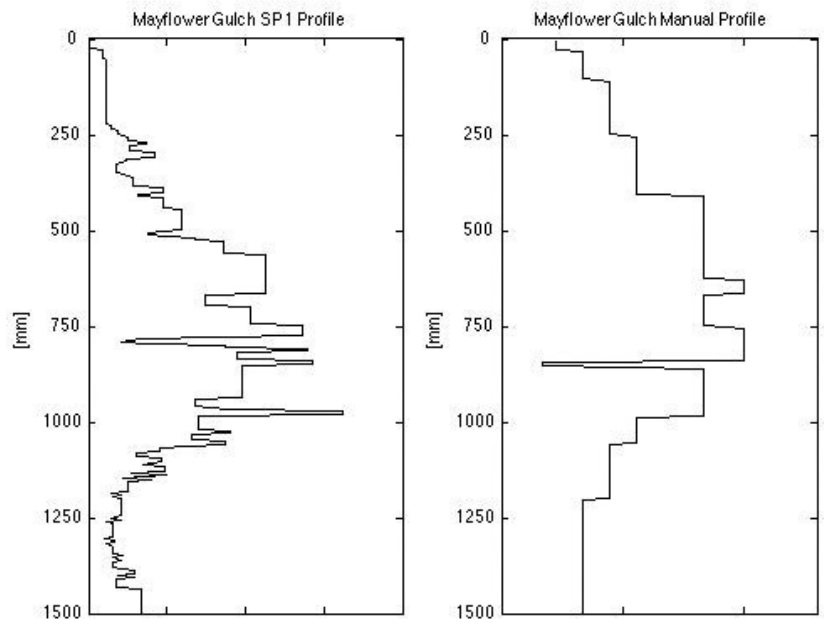
What the SP1 does NOT do:

Thomas Laakso explains, "The SP1 supports more informed decision-making but is no replacement for sound judgment and experience. The avalanche problem is incredibly complex and we are not building a magic wand to solve it. There are other factors our technology cannot measure such as wind, temperature, and on-the-ground conditions.. We present objective snowpack information and it's ultimately up to the user to decide how to integrate that information with other critical observations they are making in avalanche terrain."

"The SP1 also doesn't replace digging a snowpit in any way. There is information you can gather from a snowpit, such as shear strength, which we are not currently measuring. We encourage users of the SP1 to continue to dig, but remember snowpits only give information about a very specific location. The device can help determine if a layer of concern discovered in a snowpit continues to be prevalent on other aspects and elevations or it may find layers you don't even realize are there."

Hurdles overcome and Prior and Existing Technologies:

There have been other attempts such as the Sabre Penetrometer and the more scientific based Swiss Snow MicroPen, which is a great research tool, but AvaTech has worked over the past two years to overcome significant technology cost hurdles, making the SP1 a tool any snow professional can buy. One critical breakthrough



A comparison of a manual pit profile and a profile with the AvaTech SP1. The SP1 clearly picks up the buried surface hoar layer of concern. *By Ethan Greene and Sam Whittemore*

is the ability to measure snow stratigraphy to a several millimeter level accuracy even when the probe moves at different speeds, making it effective independent of the user.

AvaTech Winter Testing Program:

From January to May of 2014, AvaTech and a team of 50+ partners rigorously tested 25 prototype SP1 units as well as versions of the AvaNet web platform. The testing program included both lab and field-testing, with snow professionals across six different countries around the world. Continuous support and feedback throughout the program allowed AvaTech to accelerate the development of the SP1 with great energy and efficacy. A grant from the American Avalanche Association was used in support of this testing program. This article fulfills one condition of that grant. Working with testing partners resulted in an extraordinary amount of learning. Professionals dug hundreds of snowpits and compared data to the SP1 prototypes.

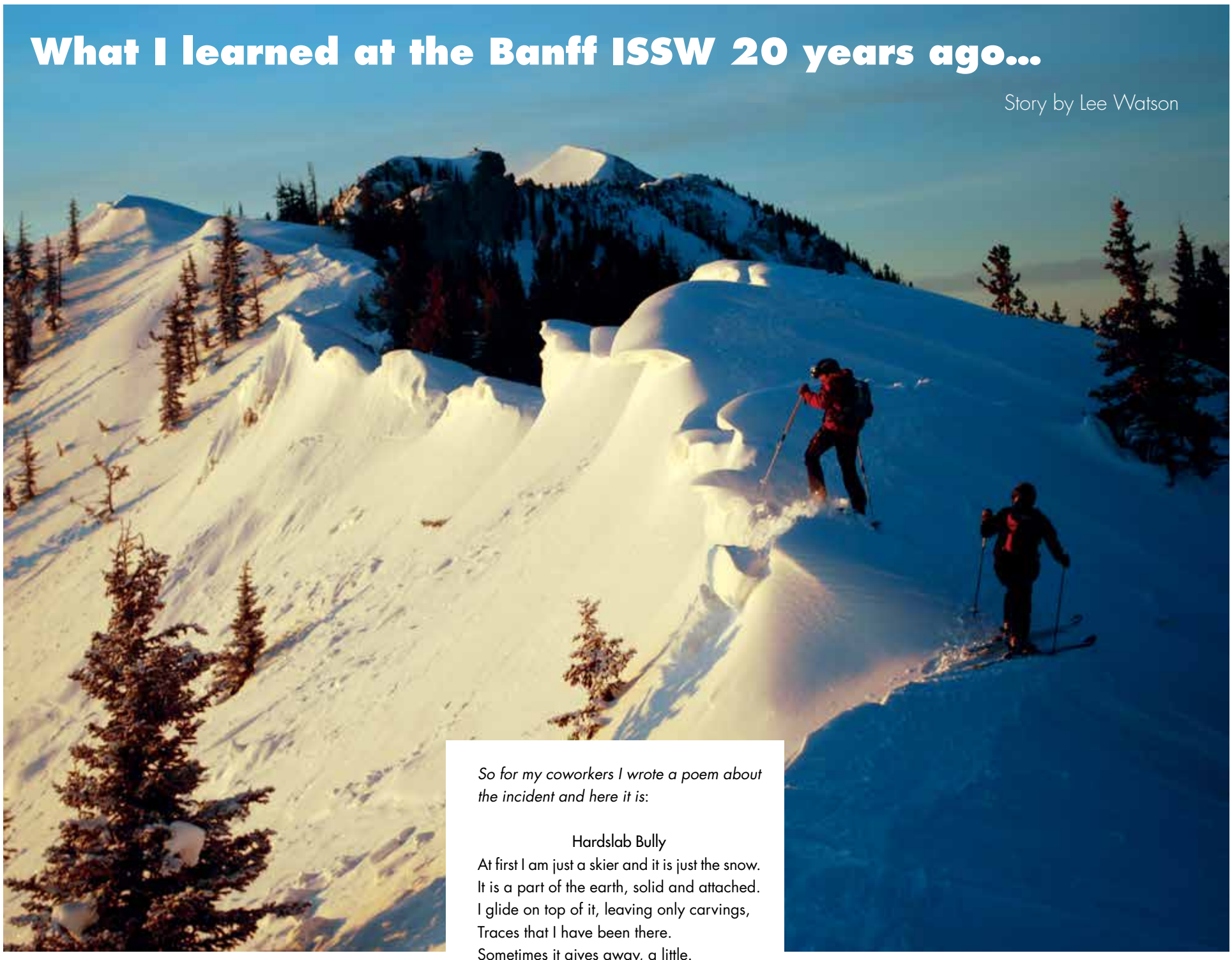
Market availability:

The AvaTech SP1 delivers in December and is available for ordering now at $2249 with a $39/mo subscription fee. The subscription fee allows complete access to the web portal AvaNet which allows the sharing and viewing of all information, as well as their great SnowPit editor tool which is an easy and effective way to catalogue and share complete snow pit evaluations.

AvaTech will be present at many of the snow and avalanche workshops around the country to interact with the community and demo their new technologies. They encourage anyone to reach out to them with feedback and ideas to contact@avatech.com.

What I learned at the Banff ISSW 20 years ago...

Story by Lee Watson



Well I can't remember. I know there was an obscure talk about Japanese snowfields that melt into shapes that tell them when to plant crops and might have some religious significance. There was another about sending thousands of ping pong balls down a ski jump to measure avalanche velocities. There may have been a humerous debate about the Canadian use of the term "Considerable." But these are all just the parts I remember because they are obscure, the oddities. Maybe it's because I don't do as well with remembering the numbers and formulas better associated with math and science. I just remember the odd stuff.

When my son's high school explained their Science, Technology, Engineering and Math "STEM" curriculum, I understood enough about integrated learning to appreciate its value. This year however, when they changed it to STEMA with the addition of Arts, it seemed to exponentially increase the possibilities. Also, because Montana State University is so close to home, I've had the benefit of great researchers and educators providing our patrol with a plethora of knowledge in snow science. Recently, beginning with a heuristics talk in Penticton, I have seen more and more interest in the human element, in how we process information and in the variety of ways people can learn. With this background, when I was caught in an avalanche and needed to provide a report to my coworkers, I felt like I had a little leeway in the way I might present it. I thought about how one of the leading snow scientists from MSU had recently diverged from his usual presentations using graphs and models and had kind of waxed poetic about a God Particle and how it related to the snow.

Though I see there is an ISSW art sale coming up this year in Banff, I don't think we need to change the name to ISSAW… yet, but I do see the Arts as another useful tool. In my home, I enjoy a painting done by a local artist that shows a beautiful section of my avalanche route.

This brings me to assess, "What did I learn at the Banff ISSW 20 years ago?". I know that each spring I look at a snowfield on a mountain near my house to tell when the river will be clear. When I was caught in that avalanche I felt a lot like a ping pong ball going off a ski jump. When I see the avalanche danger is posted as "Considerable" I have the background to consider how that term was adopted. But the big thing I learned was to be open-minded about what was presented and how I might use it and to appreciate all that is presented along with the surprises in how we eventually understand and use what we learn.

So for my coworkers I wrote a poem about the incident and here it is:

Hardslab Bully

At first I am just a skier and it is just the snow.
It is a part of the earth, solid and attached.
I glide on top of it, leaving only carvings,
Traces that I have been there.
Sometimes it gives away, a little.
Shattering like glass, the broken pieces
tumbling away like spilled milk.

This time however….
When I, I gave it a little nudge,
It had something to say.
It said "Come with me."
It said "I have something to show you.
We are leaving this place, together
because you and I are now one.
We are going someplace different
and you might not like it.
You might not even come back.
But we are going!…Now!
Because I am much bigger than you.
And for now you are a part of me."

So we went.
Me as its hostage.
It taking me on the only path it knew.
Down.

It introduced me to some trees.
The snow knew them well
and broke upon them like waves on the beach.
I didn't want to meet them and chose to address them
a little less directly.
Able to position myself enough.
To make meeting the first one
more of a casual brushing by.
A deflection.
But enough to change my direction, slightly.
An opportunity.
To avoid the other trees below.
To get out, to carve again.
No longer a part of gravity's avalanche
but a separate vector.
Slicing through the vertical chaos.
Choosing my own angle.
Out and away.
To safety.

My avalanche route that mirrors the painting. *Photo by Ella Darham*

Painting by Rachele Pohl, an artist/student at MSU.

See you at the ISSW Art sale in 2014 and again at the ISSAW Ballet in 2034.

A Bridger Bowl ski patroller for the past 21 years, Lee Watson has held a BA in English from Montana State since 1994 but only began using that degree recently to write poetry as required for a Jackson Hole patrol exchange. ❄

what's new

Alaska OSHA Update

Story by Dave Hamre

With three guide fatalities in the last three years in the Alaska Heli-Ski Industry, Alaska OSHA is engaging stakeholders in an attempt to lessen risk to heli ski guides and others in the avalanche field. One of the important issues being discussed is the appropriate amount of personal protection gear for the environment. There is considerably divergent opinions in the avalanche field about what type of gear should be required. It seems fairly certain at this point that a beacon, shovel, and helmet will be required for avalanche work in Alaska. Other devices such as an airbag may be required depending on the outcome of the review process.

Even though the primary focus for improving safety is on the heli-ski industry, Alaska OSHA is also looking at other types of avalanche mitigationwith respect to procedures used in safeguarding avalanche workers. In the near future a working group consisting of those involved in active avalanche mitigation programs will be convening to identify and discuss the commonalities in their programs and provide those to OSHA as a baseline for minimum requirements. It is not known whether the heli-ski industry in Alaska is taking similar steps.

The remaining review process for Alaska OSHA is indeterminate at this point, but it will likely include more definition of minimum gear requirements as well as increased inspection frequency. More difficult to accomplish would be safeguards or protocol modifications to the basic avalanche decision-making process that is so integral to making safe decisions in avalanche terrain. ❄

After stints working on snow safety at Alta, Alyeska Resort, and more recently at the Alaska Railroad, Dave Hamre is looking forward to being phased out of full time employment in the avalanche field soon.

Comments by Heli-Ski US on Alaska OSHA investigations

Story by Kevin Quinn

Heli-Ski U.S. Association (HSUS) is deeply concerned with the circumstances that brought about three guide deaths and the death of one customer over the past three seasons and applauds Alaska OSHA's decision to seek means by which risks to guides can be mitigated. HSUS and its members have been active participants in this process and sent HSUS' Safety Director and member representatives to the stakeholder meeting sponsored by AKOSHA. However, we strongly believe a broader approach is appropriate to address the problem. The simple fact is it is too easy for newcomers to obtain a permit to operate a helicopter skiing business on Alaska state lands. In helicopter skiing, safety costs money. A properly run program requires investment in qualified personnel, training, communications and operating equipment, and emergency response gear. Similarly, some newer entrants are treating guides and others as independent contractors, avoiding expensive worker's compensation insurance. This shoe-string approach creates an uneven playing field and demonstrates an unwillingness to invest in qualified professional personnel. With minimal thresholds to entry by new firms, existing operators that incur these expenses place themselves at a competitive disadvantage to newcomers who have not made similar investment. It is our view that the Alaska Department of Natural Resources must take a larger and more aggressive role in qualifying permit applicants.

HSUS also sees a strong need for consistent standards in the industry, and to this end HSUS has published its Helicopter-Skiing Safety & Operating Guidelines (HSOG), previously a proprietary document, for all interested parties to use as they see fit, (http://heliskius.org/wp-content/uploads/2014/01/HSOG.pdf). Among other things, the HSOGs require:

- o A formal operating plan and an emergency plan for each operation.
- o A daily weather and avalanche forecast.
- o Employment of a AAA, AAI or AIARE Level III or Canadian Level II forecaster.

We believe that the HSOG could serve as a template for AKDNR's use in adopting permit standards and hope that they elect to move in that direction.

Though HSUS represents only three operators in Alaska, three additional firms have applied for membership ("Prospective Members" in our parlance) and have shown willingness to work through our two-year qualification process. That process includes an on-site audit for compliance with the HSOG. Collectively, our member firms have had only two fatal avalanche involvements in 277 years of cumulative operations. Though we are mindful that we have been blessed by good fortune, we also strongly believe that our record is a reflection of disciplined operations and decision-making. In short, we believe that the processes and procedures recommended in our HSOG are the most effective means of risk mitigation.

A final note on avalanche airbag systems (AAS). Though we welcome this new technology, there are unanswered regulatory questions with regard to their carriage aboard helicopters. Moreover, we believe that care must be taken to assure that the AAS do not become a substitute for appropriate decision making based on competent professional avalanche forecasts. ❄

Kevin Quinn is President of Heli-Ski U.S. Association, Inc.

decision-making

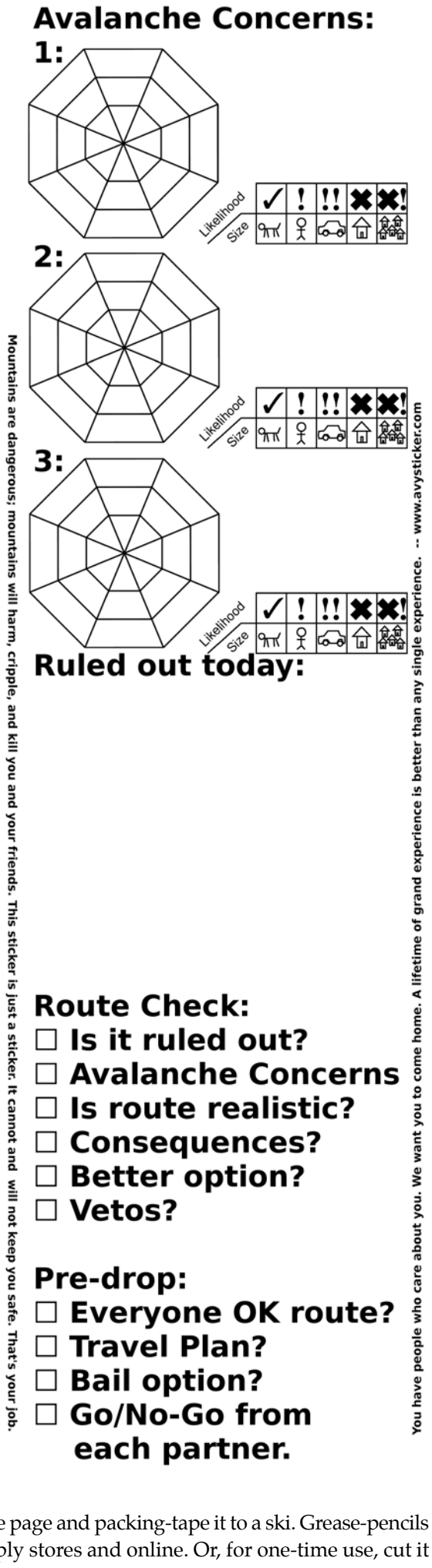
AvySticker: Safety Notes on Your Ski

By Charlie Hagedorn

Do you value using your avalanche fieldbook, but it's not in your pocket on every tour? Is it too easy to get drawn into terrain you ruled out? Do you want to use checklists with your partners, but worry it'll take too long? Perhaps you'll find an AvySticker useful.

The AvySticker is a new low-tech idea. It sticks the day's ruled-out terrain, avalanche concerns/problems, and helpful checklists to your ski tip. Important ideas from avalanche fieldbooks are made more accessible. You can't forget the AvySticker at home, because it's on your ski. You can consult it instantly, because it's not in your pocket or pack. Even when it's not filled in with the day's plan, the sticker motivates thoughtful travel. The AvySticker is only a sticker, just putting it on a ski won't make you safer -- if it inspires you to travel more safely, it's served its purpose.

How does it work? It's a 3x10 (75x254 mm) sub-five-gram ski-tip bumper-sticker you can see while you ski. Write on it with a grease-pencil/china-marker, which stays on all day. Erase with an ardent fingertip or a paper towel. You can note the day's avalanche concerns, a concern-specific rose, and icons for likelihood and size. Your ruled-out list is the heart of the AvySticker: places you won't go and things you won't do. It's easier to stick to your plan when it's in front of you and in your handwriting. You can point it out to a partner, too. As you travel, a pair of checklists, inspired by the AIARE Communication Checklist, are helpful prompts. The ‚ÄúPre-drop‚Äù checklist gives a nice rhythm to discussions at skin/ski transitions.



You can try the AvySticker concept right now: cut it out of the page and packing-tape it to a ski. Grease-pencils are available at drug/office-supply stores and online. Or, for one-time use, cut it out, fill it in with a pen, and tape it on.

The AvySticker enters its first full winter season with a fourth revision. We love getting your feedback; we'll send a free AvySticker in return for suggestions incorporated into future versions. Please send suggested changes or comments to ideas@avysticker.com .

To learn more or to get an AvySticker ($5, half of any profit to avalanche education), visit www.avysticker.com . ❄

Charlie Hagedorn is a Seattle backcountry skier. Thanks to Susan Ashlock, Scott Schell, and NWAC, among many, for urging a disciplined recreational approach to snow, inspiring the AvySticker.

aaa news

AAA Spring Board Meeting Minutes

In attendance April 26, 2014: John Stimberis, Kirk Bachman, Damian Jackson, Halsted Morris, Lynne Wolfe, Scott Savage, Stuart Thompson, Aleph Johnston-Bloom, Dave Hendrikson, Bill Williamson, Jaime Musnicki, Blase Reardon via Skype. Guests=Maura Londgen, Don Sharaf

Financial Report: Approximately 100K in non-AVPRO/sales revenue, AAA in similar financial position to past few years.

Membership report: Jump in expired members, discussion about why – accounting, digital renewal process. Section reps will contact people to remind them about renewal, has worked in the past. AAA Governing Board's time may be better spent going after organizations rather than individuals. Need to attract the younger professionals and potential members to replace expiring members.

Pro development grants: Received 5 applications to date for grant requests, total = $3500. CIL check is for over $9000 this year (was $11000 last year). May need to trim/partially fund requests once all requests are received. Utah hasn't written required TAR article on their event yet. Unsure if NW will be asking for funds. Executive Director to determine final applicant pool in coming months, Executive Committee to discuss and appropriate funds.

SWAG update: Sold out this year, made a second order, have a lot on hand. Eric Lutz is interested in editing future editions, need to talk to Ethan Greene and Karl Birkeland about when to do it. Ethan is onboard to do the next edition with whoever will be taking over after him. Ethan feels that whoever does this should be paid something as it's quite an endeavor. Ethan is going to look at the need for a new edition at this time and create a timetable before our fall meeting. Executive Director will investigate eVersion of SWAG with publishers.

Executive Director position: Jaime: Going well in general, getting feet on the ground. Would like more information about some history/big picture items but amount of empowerment is good. Need clearer vision for sponsorship proposals. Defining the AAA mission statement is very important. General discussion on the AAA being spread too thin, following through on current projects, deciding whether to add more things to our plates, dealing with too much administrative material/minutiae at meetings. General GB consensus is we're not effective working how we currently do it, need to pull back and finish what we've started. Need to create strategic plan, yearly action plan, "to do list" for committees/work groups. LW: Need to get summary of Snoqualmie Summit meeting from Dale. KB: need to get a handle on what the hanging items are. Need to finish what we have going before visioning, create a summer workplan.

COMMITTEE BUSINESS/REPORTS

Awards: Memorial list: Everett Birch Oct 21, 1968, killed at a mine in an inbore avalauncher pre-detonation. Colin Sutton, Wolf Creek, doing helicopter skiing pre-studies, killed in avalanche March 4, 2014. Aaron Karitis, March 15, 2014 Haines heli-guide. Wallowa accident to be added with more information.

Publications/TAR: One themed issue on accident analysis. Need a new graphic designer, working on a new job description to be posted on avalanche.org. Hiring committee and will submit decision to GB for a vote, need to have someone hired by August 1. Advertising: Paul sold more ads, doing well in general. Avalanche history book: LW still has time and energy to do more interviews. TAR history book: not a priority for the organization, can't recommend putting time and energy into it at this point.

Membership: Stuart – Recommends to accept all new pro members as per sheet handed out in morning meeting packet. BW moves to accept list, JS seconds, motion carries. AAA to revise online pro application so we don't have issues with application matching actual experience.

New Pro and Member Affiliates: Motion to eliminate the application deadline for the member affiliate process, motion carries.

Education: Kirk AVPRO: Dallas did a stellar job running the course in a difficult year (staffing, snowfall, site logistics, lack of existing curriculum). Alpine Meadows staff was great, lots of support. Difficulty with finding AAA CIs to instruct, ended up finding very qualified but non-CI instructors. KB attended, was impressed with instructors and course organization. Discussion about CI Program director and AVPRO director working together in the future. KB says great venue, especially with Mt. Rose and Alpine Meadows participating. Discussion about existing AVPRO material being passed on to AAA.

CAA/SAS Request: Reference to email chain. SAS asking CAA to host pro module. AIARE talked to AAA about the plan. Questions: is this a one-time deal (professional development) or the beginning of a series of courses? What is the AAA's role in this matter? How will this affect our efforts to inventory current US educational offerings? Timing is difficult at best due to our desire to alter the US education track. CAA (Emily) has no plan to run courses in the US, just responded to the SAS about a one-time offering of part of the level 2 module. Supply and demand question, quality advanced field-based education options are limited. SAS still going to be running level 3s, views this as an extension and continuing education. Long discussion about this issue. GB feeling is to ask SAS board and CAA to hold off for a year while we develop pro-rec split in education and to consider reciprocity issues with CA courses and US courses.

Research: Zero practitioner grant applications this cycle. Should AAA extend deadline to Sept 1 (same deadline as research applications)? Theo Meiners grant administrators considering whether to change grading scale to encourage AK practitioner research. AAA GB has mixed feelings about this, general consensus is to go with best proposals and use AK as a tie-breaker for equal proposals.

OLD/NEW BUSINESS

CI representative: Jake Hutchinson is appointed new CI representative.

SAR committee chair: Nick Armitage and Maura Longden interested. Discussion on chairs vs co-chairs, the ability of the AAA to pay for one of them to attend IKAR meeting. Nick and Maura appointed as co-chairs.

Upcoming elections for executive committee and section rep: Executive Director to pursue eVoting for fall 2014 election cycle.

Update on launching of **new av.org homepage:** Need to complete listing-criteria project, hoping to launch new site by June 1 at latest.

Social media: Need a social media blitz with the launch of the new avalanche.org website. Aleph volunteers to be "social media czar" for the AAA, an unofficial position.

Corporate Partnerships and Sponsorships: BCA already on board in some way, Patagonia interested in continuing and furthering AAA relationship (gave us merchandise and different levels of pro deals), possibly funding avalanche education in some way. Also speaking with Ortovox and Black Diamond. Executive Director could use guidance/expectations/empowerment. Consider hiring a consultant to develop marketing/advertising/branding plan and educate AAA about it. Also discussions about whether to have someone help with general revenue generation (foundations, members, sponsors, etc.). Stephen Barnes is one contact to consider. Attending trade shows (SIA, Outdoor Retailers, etc) – gear manufacturers are asking if we are doing this, would be very useful in branding and making connections and deals.

Wild Apricot/eNewsletter launch: Trying to strategically connect with membership, only in non-TAR months, using template in Wild Apricot. Current plan is three times each winter and once in the summer. Executive Director will solicit material and input on newsletter content.

Membership Survey & Strategic Plan: Waiting for results/passwords.

Employment Policies: President working on this, pending.

Online Store: Pending, leftover gear is at Treasurer's home.

AK Heliski Industry stakeholder meeting: Discussion about upcoming May 21, 2014 meeting in Anchorage with AKOHA and industry stakeholders about worker safety. May have implications that affect entire avalanche industry. See what NSAA and other stakeholders say and think, participate, and support them as they wish – we don't need to issue edicts or tell stakeholders or regulators what they should be doing. AAA to pursue having AAA representation at the meeting, but not presenting opinions on the AAA's behalf *(see pg. 7 for more.)*

Avalanche Awareness PSA project request (Mike Friedman): Received email recently about short film avalanche safety production project. Focusing on high risk backcountry users. Mike Friedman has been approached by several donors who want to fund it via a non-profit, wondering if we can work as a pass-through agency. Discussion: do we have any editorial control? How are we branded/represented? Executive Director to negotiate with him about this, GB is good in theory with the general idea.

Revising US Avy Education Framework (Pro and Rec Tracks): Re-cap Alta Meeting (Pro/Rec Split): AIARE proposed revised education tracks, called a stakeholder meeting at Alta in October, try to determine consensus/direction. At that meeting, determined goals for the night and the future. Formed a working group that represents stakeholders – since the meeting, the group has morphed a bit. Meeting over several days in July in Stanley, ID. Updates to be presented at AAA board meeting at ISSW.

2014 Pro Observation Project: Kirk Bachman attended NAS classroom, AAI Level 3, AIARE Level 3, AVPRO. All courses referencing SWAG. Collect questionnaires from course providers, students, industry employers (still being created) to gather information and feedback. Some summary observations: 1) Some deficits in the observations due to work conflict/volunteer nature of Kirk's observation mission this winter. 2) Two distinct audiences: Avalanche Recognition and Avoidance (guides, avalanche center forecasters, observers)…Active Avalanche Mitigation (highway, patrol, industrial). We need to develop a common standard for snowpack tests, observation, and recording (SWAG application) and there's a need for continuing education for trainers/instructors where they all get together to get on the same page. Kirk presents the AIARE and AAI proposals for recreational splits. Don Sharaf says land managers starting to require certifications or move in that direction, not as interested in hearing about training completed. Don feels the AAA should recognize that this will be a very cumbersome and involved process. Revisions to education: have a core curriculum that works for both avoidance and mitigation-based professionals. All courses need to have some element of review.

GB fall meeting to be held in conjunction with ISSW 2014 in Banff. ❄

snow science

An Up-to-Date Perspective on the Effectiveness of Avalanche Airbags

Story by Pascal Haegeli, Markus Falk, Emily Procter, Benjamin Zweifel, Frédéric Jarry, Spencer Logan, Kalle Kronholm, Marek Biskupic, Hermann Brugger

Over the last five years, the use of avalanche airbags has increased dramatically, both among professional guides and amateur recreationists. While there were only a couple different airbag types on the market ten years ago, backcountry enthusiasts can now choose from a wide range of models produced by at least four different manufacturers. In additional, a few new manufacturers are pushing into the growing market with their own innovative designs.

Avalanche airbags have a tremendous potential to save lives, since they are the only avalanche safety device that can directly prevent or reduce the severity of avalanche burial—the root cause of the majority of avalanche deaths. As a consequence, some avalanche warning centers now recommend airbags as a useful complement to the traditional avalanche safety tool kit of transceiver, probe and shovel. Whereas the underlying mechanism for the effect of avalanche airbags[i] has been validated conclusively using mathematical models and field tests, the precise effect of airbags on avalanche mortality is still being debated. While manufactures like to present airbags as the ultimate avalanche safety device (e.g., "97% survival", "8x safer!"[ii]), prominent avalanche educators try to warn against the 'silver bullet' marketing by highlighting that the number of lives saved per 100 fatalities might only be in the single digits.[iii] Since both sides claim their analyses are based on solid data and rigorous statistics, it is difficult for the layperson to determine what's right and what's wrong. However, an accurate and easily understandable presentation of the true effect of airbags on avalanche mortality is important. According to a study by Christie (2012) from Backcountry Access, survival statistics are the most important reason for airbag purchases among their customers.

A number of independent statistical evaluations have assessed the effectiveness of airbags, the most prominent of them is the analysis by Brugger et al. (2007). However, due to the small number of incident records involving airbags available at the time, the analysis has limitations and the results should be interpreted cautiously. More recently, Shefftz (2012) compared the available ABS airbag involvement data to various avalanche accident datasets to estimate the range of impact airbags might have on avalanche survival. However, this type of comparison also has challenges that limit the resulting conclusions. The goal of this article is to provide an up-to-date perspective on the effectiveness of airbags based on a detailed study we recently published in the journal Resuscitation (Haegeli et al., 2014). In addition to simply presenting the results of the study, we also want to take this opportunity to describe the challenges that evaluations of avalanche safety equipment face in detail. We hope that this information will help backcountry recreationists to assess marketing claims more critically and make better informed choices when deciding whether to add an airbag to your avalanche safety kit or not.

Mortality, mortality difference and mortality ratio

Whenever you read statistics—airbags or otherwise—you should immediately ask yourself the following questions:

- What is the question they are trying to answer?
- Where is the dataset coming from?
- What kind of assumptions were made during the analysis?

Without a clear understanding of this context, the presentation of statistical figures is meaningless, even if number might actually be technically correct.

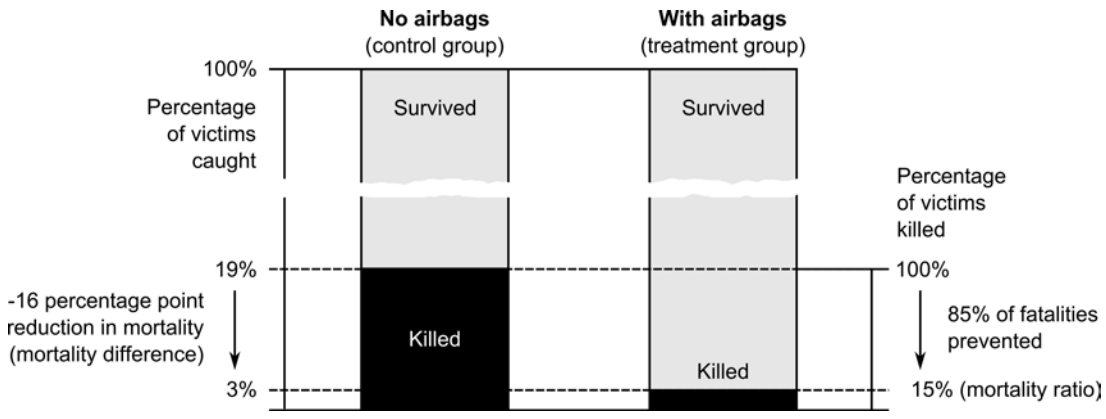


Fig. 1: Mortality difference and mortality ratio illustrated with the results of Brugger et al. (2007)

The first step of examining the effectiveness of any safety device is therefore to specify the question you want to answer. We think that the most interesting questions for the evaluation of avalanche airbags are:

1) How does the use of an avalanche airbag affect my chance of getting killed in a serious avalanche involvement?

2) How many avalanche fatalities could be prevented with the widespread use of avalanche airbags?

The statistical measures used to answer the two questions are the mortality difference for the first question and the mortality ratio for the second question. These two measures are closely related, but they offer different perspectives on the effectiveness of airbags and it is important to clearly understand their differences.

We are using the results of the study by Brugger et al. (2007) to explain the meaning of these two statistical measures in detail. The dataset used by Brugger and colleagues consisted of 1504 avalanche involvements occurring in open terrain in Switzerland and Austria between 1990 and 2005. Thirty-five of the avalanche victims included in this dataset were equipped with airbags during their involvement. Out of 100 victims involved in avalanches without airbags (control group), 81 survived because they did not sustain any fatal injuries and did not get buried or were found and extricated in time (Table 1). This is equivalent to a mortality rate of 19%. Out of 100 avalanche victims equipped with airbags (treatment group) 97 survived, which corresponds to a mortality of 3%.

Table 1: Dataset of Brugger et al. (2007)

	Survived	Killed	Total
Without an airbag (control)	1191 (81%)	278 (19%)	1469
With an airbag (treatment)	34 (97%)	1 (3%)	35
Total	1225	279	1504

Based on the data presented in Table 1, Brugger et al. (2007) showed that that the use of avalanche airbags results in a significant reduction of the mortality by 16 percentage points from 19% to 3% (Fig. 1, left axis). This is the so-called mortality difference. The mortality ratio scales or normalizes the mortality of victims with airbags with the original mortality of victims without airbags (mortality of the treatment group divided by the mortality of the control group; Fig. 1, right axis). In the study of Brugger et al. (2007), the mortality ratio is 15%, which means that out of 100 avalanche victims killed without airbags, 15 would still die even if all were equipped with avalanche airbags. In other words, 85 of 100 fatalities could have been prevented with the use of airbags.

Only relevant cases

To date, the vast majority of analyses on the effectiveness of airbags were based on an airbag involvement dataset that was collected collaboratively by the ABS airbag manufacturer and the WSL Institute for Snow and Avalanche Research SLF. This dataset is almost entirely European and it includes a wide spectrum of incidents ranging from large avalanche with multiple burials to small avalanches where single victims managed to avoid being buried. While all of these cases provide valuable information on airbag performance, not all of them are suited for a statistical analysis of the effect of airbags on mortality. A detailed description of the criteria used to put together the analysis dataset (Were all known airbag incidents included in the analysis or did it only focus on a specific subset?) is of utmost importance when interpreting statistical results.

One of the goals of our study was to collect a larger and geographically more comprehensive dataset that is well suited for truthfully estimating the effectiveness of airbags. Existing records of well-documented avalanche accidents involving at least one airbag user were collected from data sources in Canada (Canadian Avalanche Association), France (National Association for Snow and Avalanche Studies), Slovakia (Avalanche Prevention Center), Norway (Norwegian Geotechnical Institute, Norwegian Red Cross), Switzerland (WSL Institute for Snow and Avalanche Research SLF) and the United States (Colorado Avalanche Information Center). Since airbags are designed to prevent or reduce the severity of avalanche burial, we focused on avalanche involvements with the potential for full burial. This was accomplished by including only incidents with avalanches of a destructive size 2 or larger according the Canadian or American avalanche size classification and including only victims who were seriously involved in the avalanche. This means that they were either seriously involved in the flow of the avalanche or hit by the avalanche from above then partially or completely buried. Victims who were only slightly moved at the edge of the avalanche, managed to remain standing during entire involvement or even ride out of the avalanche were excluded from the dataset as airbags are unable to affect the outcomes of these types of involvements. The resulting dataset consists of 245 incidents with a total of 424 seriously involved individuals. Two hundred and forty-six (58%) of the included victims had an inflated airbag, 61 (14%) had an airbag that was not inflated during the involvement, and 117 (28%) were not equipped with airbags.

Unbiased control group

The accurate assessment of airbag effectiveness requires a reliable control group of victims without airbags. The challenge is that many avalanche incidents with good outcomes (i.e., no fatalities or major injuries) simply never get reported. This prevents us from calculating a reliable base mortality for avalanche involvements. Since both airbag manufacturers and avalanche safety researchers are actively hunting for the information on avalanche accidents involving airbags, it is likely that the reporting rate of non-fatal avalanche accidents with airbags is considerably

Continued on next page ➡

Effectiveness of Airbags

(continued from previous page)

higher. This difference in reporting rates can unintentionally skew the results of statistical analyses on the effectiveness of airbags.

To obtain a control group that is as comparable as possible to our airbag cases, we limited our analysis to only include accidents that involved both users and non-users of avalanche airbags. This allowed us to extract both the treatment group and the control group from the same accidents, therefore avoiding any reporting biases. However, the price for this unbiased control group is a considerably smaller dataset that only includes 35% (106 of 207) of the available records on seriously involved individuals with airbags and is skewed towards larger avalanches with multiple involvements. Remember this when interpreting the final results.

Controlling for other factors affecting mortality: adjusted mortality rates

Airbags are clearly not the only factor affecting your chance of surviving an avalanche involvement. The size of the avalanche, your location when the avalanche releases, the character of the runout zone, whether you get injured and whether you wear an avalanche transceiver all have the potential to affect the outcome of your involvement. Because all of these factors work together, a simple cross table like the one shown in Table 1 is unable to correctly separate the effect of airbags from the other contributing factors.

To account for the other contributing factors in our analysis, we collected information on a large number of parameters describing the characteristics of the incident, the avalanche and the victims. We then examined the influence of all these factors on mortality simultaneously using a statistical technique called binomial logistic regression analysis. This method allows us to properly identify and separate effects of the individual contributing factors. The results of this analysis were then converted into adjusted mortality rates, which are interpreted in the same manner as mortality rates calculated from cross tables. The interested reader is referred to our paper in Resuscitation to get the full list of parameters included in the analysis and read the full details on the logistic regression analysis.

What did we discover?

The results of our analysis support the finding that airbags significantly reduce the mortality in serious avalanche involvements, but the effect is lower than previously reported. The analysis revealed that airbags affect mortality only indirectly through their influence on victims' grade of burial.[iv] Other factors affecting grade of burial are avalanche size (the larger the avalanche the higher the likelihood of a critical burial) and whether the victims sustained a major traumatic injury during the involvement (higher likelihood of critical burial with major injury).[v] The adjusted risk of critical burial is 47.0% for victims without airbags or with non-inflated airbags, and 20.1% for users with inflated airbags.

Mortality is subsequently determined by grade of burial, avalanche size and major traumatic injuries. The adjusted mortality is 43.8% for critically buried victims and 2.9% for non-critically buried victims. The adjusted mortality with and without an inflated airbag can now be calculated by multiplying the adjusted risk of critical burial with respect to airbag use and the adjusted mortality with respect to critical burial as illustrated in Fig. 2.

While the mortality without inflated airbags is 22.2%, the mortality with inflated airbags is 11.1%. This results in an adjusted mortality difference of 11 percentage points (95% confidence interval is -4 to -18 percentage points) and an adjusted mortality ratio is 0.5 (95% confidence interval is 0.3 to 0.7).

This means that out of 100 victims without airbags seriously involved in avalanches similar to the ones included in the analysis dataset 22 are killed and 78 survive because they did not sustain any lethal injuries, did not get buried during their involvement, or were found and extricated in time. Out of 100 victims equipped with inflated airbags, only 11 would have been killed. In other words, an additional 11 victims would have survived due to the airbags, which means that half of all fatalities could have been prevented. These effects are significant, but they are not as good as previously reported (-11 percentage points versus -16 percentage points in Brugger et al., 2007). Furthermore, the mortality of airbag users is significantly higher than previously reported (11% versus 3% in Brugger et al., 2007). While this difference is partially due to the fact that our analysis focused on larger avalanche accidents with multiple involvements, it clearly highlights that airbags do not guarantee survival under all circumstances. Even if all victims in the present dataset were equipped with inflated airbags, one of every nine victims would have died.

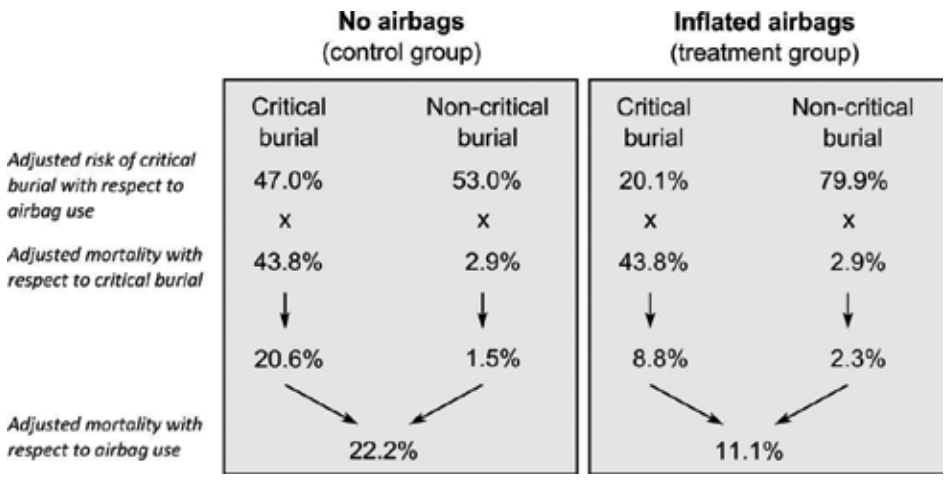


Fig. 2: Calculation of adjusted mortality with respect to the use of inflated airbags.

What about non-inflations?

So far we have examined only the benefit of inflated airbags. In other words, the 11 percentage point decrease in mortality represents the best case scenario when airbags are properly deployed and inflate as designed. However, past studies have repeatedly highlighted non-inflations as a serious problem for the performance of airbags. To examine non-inflations, we used all available records of airbag users including ones from accidents that only involved single users. The resulting dataset consisted of 307 records from 245 accidents. The overall non-inflation rate within this sample was 20% (61 of 307), which is very close to the rate reported by Brugger et al. (2007). This non-inflation rate reduces the 11 percentage point decrease in mortality from inflated airbags to roughly 9 percentage points (i.e., 80% of 11 percentage points). This clearly highlights that non-inflations still pose a considerable threat to the airbag performance.

What are the causes for these non-inflations? Information on suspected causes was available for 52 cases:

60% deployment failures by users
12% maintenance errors (e.g., canister not attached properly)
17% device failures (i.e., performance issues that resulted in design and/or production revisions)
12% destruction of airbag during involvements

Relative to the total number of users, the rate of airbags destroyed in involvements was 2% (6 of 307) and the rate of device failures was 3% (9 of 307).

To better understand the reasons causing users not to deploy their airbags, we examined the dataset for relationships between non-deployment and any relevant victim or involvement characteristics. Since we did not detect a significant relationship between deployment rates and avalanche size, non-deployments do not seem to be the result of more violent involvements. However, we found that the non-deployment rate is significantly lower among avalanche professionals (e.g., guides, ski patrollers, avalanche technicians) than recreationists (5% versus 14% respectively). This suggests that familiarity with airbags and their deployment procedures may considerably improve the effectiveness of these devices.

How about risk compensation?

Risk compensation is a common concern when weighing the pros and cons of avalanche airbags. Are users going to feel less vulnerable when wearing an airbag and therefore expose themselves to a higher level of avalanche hazard? While there is no empirical evidence to date on risk compensation behaviour with respect to airbag use, it is a well-studied phenomenon in other areas. Hedlund (2000) offers a summary of existing evidence on risk compensation with respect to road safety initiatives. He states that while risk compensation does occur—even though not consistently—it generally does not eliminate the safety gains from the programs, but only reduces the size of the expected effect. It would be extremely difficult to collect the necessary data to properly quantify the effect of risk compensation on the effectiveness of airbags. However, Hedlund (2000) provides an interesting personal list of four characteristics of safety equipment or initiatives that make risk compensation more likely:

1) Is the piece of safety equipment obvious? Do I even know it is there?

2) Does the piece of safety equipment affect me negatively, physically and/or mentally?

3) Does the effect of the piece of safety equipment directly relate to the motivation and objective of my activity?

4) How much control do I have over my actions? Can I even change my actions if I want to?

Airbags seem to generally score highly on all of these characteristics:
1) It is difficult to forget the fact that you are carrying an airbag as they require frequent attention.

2) Airbags are expensive and heavy, and handling them during a trip can have its challenges.

3) If your primary reason for going into the backcountry is to ski challenging terrain, the benefits of airbags are perfectly aligned with your objective; if you are simply going into the backcountry to enjoy nature and calm, the effect of airbags is much less connected to your goals.

4) While amateur recreationists have complete freedom and control over their actions, avalanche professionals are likely more restricted due to company procedures and policies or professional best practices.

Based on this list of characteristics, it can be assumed that that risk compensation behaviour is likely among airbag users, particularly among recreationists who are interested in pushing their physical and athletic limits.

While our study does not provide any information regarding the presence of risk compensation behaviour with airbags, the results of our analysis offer some insight about the possible consequences of risk compensation behaviour. The parameter estimates from the binomial logistic regression analysis on critical burial indicate that the risk reduction gained from the use of an airbag is roughly equivalent to the risk increase from being involved in an avalanche of one size class larger. This means that personal safety benefits from airbags are quickly nullified if individuals use them to justify increased exposure to terrain where larger avalanches are likely.

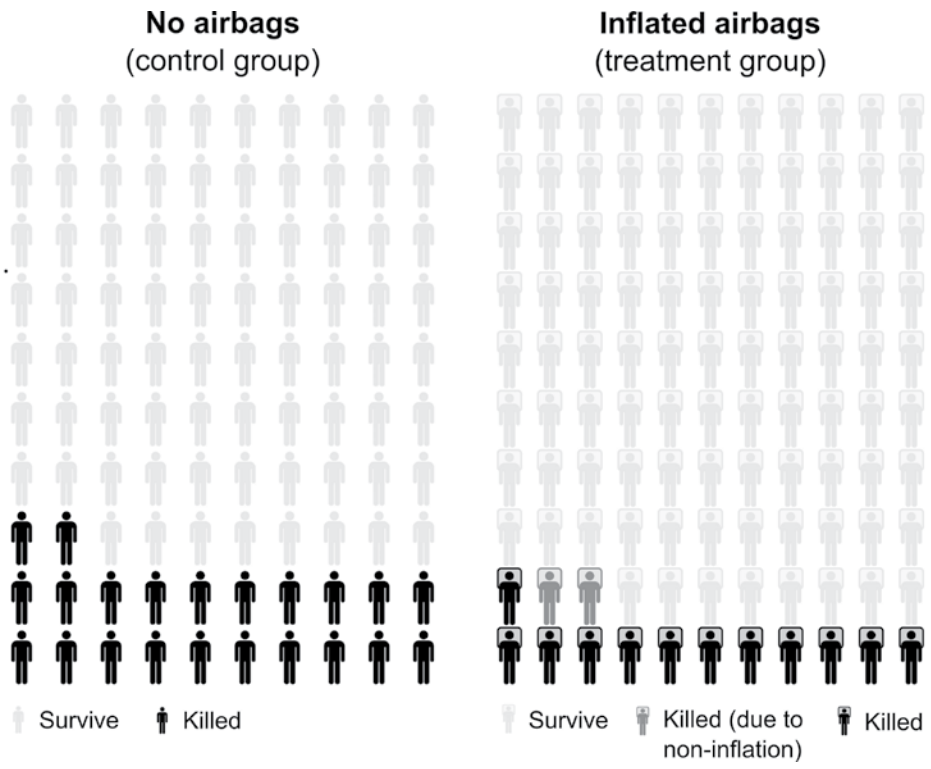


Fig. 3: Effect of airbags on the mortality of victims seriously involved in avalanches.

Limitations

Clearly stating the limitations of an analysis is important when presenting statistical results. In our analysis of the effectiveness, the sample of airbag user records was substantially smaller than the complete dataset (201 records were excluded out of 307 total) to ensure an unbiased control group. The resulting dataset was therefore skewed towards large avalanches with multiple involvements. Furthermore, the dataset had a lower percentage of avalanche professionals and a higher percentage of victims located in the track or runout when the avalanche was triggered. Remember these limitations when interpreting the mortality statistics presented in this article. While the mortality among airbag users in the excluded records (i.e., smaller avalanches, single involvements) is smaller than in the analysis dataset, it is unclear how the effect of airbags shown in the present analysis transfers and contributes in relation to the reduced mortality from smaller avalanche and other differences.

Take home messages

What are the most important take home messages from our study?

- Airbags are a valuable safety device, but their impact on mortality is lower than previously reported and survival is not guaranteed.
- For individuals seriously involved in avalanches of size 2 or larger, the use of an inflated airbag reduces the risk of dying from 22% to 11% (Fig. 3). This means that inflated airbags will save about half of the victims who would have otherwise died.
- Non-inflations remain the most considerable limitation to the effectiveness of airbags. The observed overall non-inflation rate from all causes is 20%.
- If non-inflations are taken into account, airbags reduce the risk of dying from 22% to 13% (Fig. 3) and the proportion of saved victims is only 41%.
- Sixty percent of all non-inflations are due to deployment failures by the user. Familiarity with deployment procedures and proper maintenance are paramount for ensuring that airbags work properly.
- Personal safety benefits from airbags are quickly nullified if users use them to justify increased exposure to terrain where larger avalanches are possible.

Where to go next?

While our results show that airbags can reduce mortality in serious involvements in general, the analysis does not provide any insight about the benefit of airbags under different circumstances. For example, it would be useful to estimate and compare the effectiveness of airbags in avalanches with smooth runout zones versus avalanches with terrain traps. Another interesting question would be to examine the effectiveness of airbags as a function of the location of the victim when the avalanche was triggered (start zone, track, runout). However, collecting reliable avalanche accident data is challenging and records are often incomplete. We would like to encourage national avalanche safety agencies, international search and rescue associations, airbag manufacturers and researchers to work together to develop standardized data collection protocols to facilitate future studies. In addition, we would like to encourage recreationists to diligently report all types of avalanche involvements to the local avalanche warning services. The resulting richer datasets will facilitate more detailed studies that will further improve our understanding of the benefits and limitations of airbags and other avalanche safety devices, avoid misleading statements on the impact of these devices, and help users to make better informed choices.

Acknowledgements

We thank the many individuals who contributed to the collection of avalanche accident information that made this research possible. We would also like to acknowledge Bruce Tremper and Jonathan Shefftz, who provided valuable comments on an earlier draft of this paper.

References

Brugger, H., H.-J. Etter, B. Zweifel, P. Mair, M. Hohlrieder, J. Ellerton, F. Elsensohn, J. Boyd, G. Sumann, and M. Falk, 2007: The impact of avalanche rescue devices on survival. Resuscitation, 75, 476–483.

Christie, S., 2012: Avalanche Airbag Survey: A U.S. Perspective. Paper presented at 2012 International Snow Science Workshop in Anchorage, AK, 361–362 [available at http://arc.lib.montana.edu/snow-science/item.php?id=1700].

Haegeli, P., M. Falk, E. Procter, B. Zweifel, F. Jarry, S. Logan, K. Kronholm, M. Biskupic, and H. Brugger, 2014: The effectiveness of avalanche airbags. Resuscitation.

Hedlund, J., 2000: Risky business: safety regulations, risk compensation, and individual behavior. Injury Prevention, 6, 82–90.

Shefftz, J. S., 2012: Enhanced avalanche survival from airbag packs: Why can we learn from the data? The Avalanche Review, 30, 8–9.

Corresponding Author

Pascal Haegeli is a Canadian avalanche researcher and safety consultant based out of Vancouver, BC. His interdisciplinary research aims to allow backcountry travellers to make better informed choices when heading into avalanche terrain. Pascal is also an adjunct professor at the School of Resource and Environmental Management at Simon Fraser University.

[i] Inverse segregation, also known as the "Brazil nut effect", naturally sorts particles within an avalanche according to size with larger particles being moved towards the surface of the avalanche. Inflated avalanche airbags make avalanche victims, already large particles, even larger particles within the avalanche, which increases their chances to end up on top of the debris before the avalanche comes to a stop. Buoyancy effects, which are used by floatation devices, do not play a role in avalanche airbags.

[ii] https://www.abs-airbag.com/us/abs-survival-principles.html.

[iii] Dale Atkins in the 2011 November issue of Power Magazine (http://www.powder.com/stories/know-boundaries-5/).

[iv] Grade of burial was defined as either critically buried (i.e., head of the victim under the snow and breathing impaired) or non-critically buried (i.e., unobstructed airways).

[v] Traumatic injuries are considered major if the injured requires hospitalization.

Crown Profiles

The Canyons Avalanche Trial

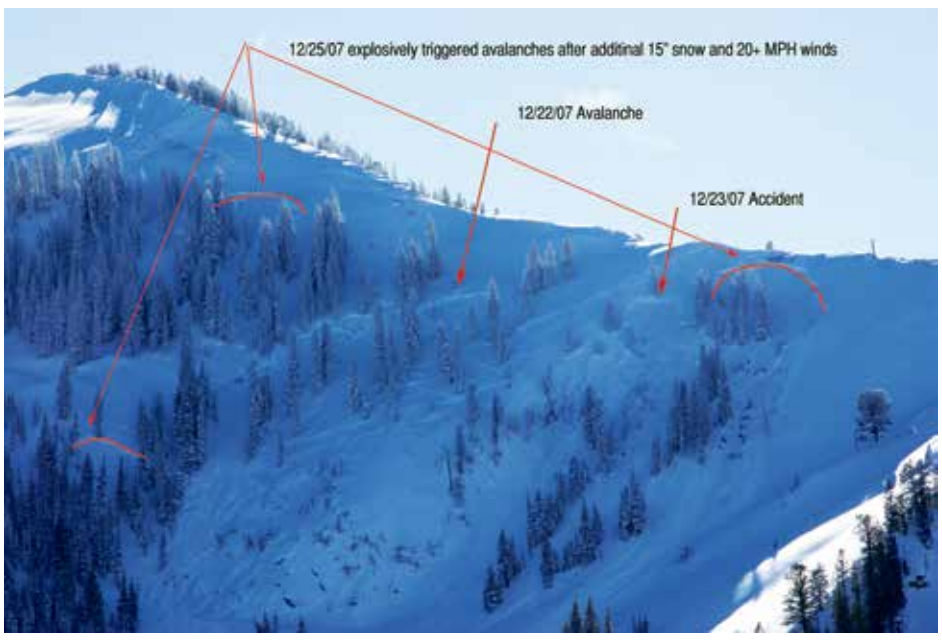
Story by Liam Fitzgerald

Photos by Jake Hutchinson

On December 23, 2007, there was an in-bounds avalanche at The Canyons Resort in Park City, Utah. The avalanche occurred in Red Pine Chute, near the top of the 9990 chairlift. Four people were caught, with one totally buried. The twelve-year-old boy who was buried was quickly found with a probe, but was not breathing and had no pulse when he was recovered. He responded to CPR, and began breathing on his own prior to transport. Tragically, Jesse Williams, a 32-year-old skier from Grand Junction, Colorado, died on the scene from trauma. The Williams family sued The Canyons Resort for negligence, and the resulting trial took place in Park City, Utah, in November of 2013. This was the first fatal avalanche accident to result in a jury trial in this country since the Alpine Meadows avalanche trial in 1984.

The 2007/08 season started out with below-normal snowfall along the Park City Ridgeline, resulting in a weak, shallow snow pack throughout the area. From December 7-22, The Canyons Resort received approximately 60" of new snow, and 4.6" of SWE. This resulted in numerous avalanches throughout the resort in the days prior to the accident, but only one avalanche in the 9990 area was observed to have failed on the weak faceted snow that had developed during the fall. The size of that event prompted the Canyons Ski Patrol to use more explosives than normal in adjacent paths on the morning of 12/22/07, including Red Pine Chute, but results were limited to shallow, soft-slab avalanches. The entire area, including Red Pine Chute was opened to the public on the afternoon of December 22. This was the first time the north side of 9990 had been open to the public that season.

The Plaintiff's attorneys based their case on the idea that the area was unsafe, and that the Canyons Resort was aware of this, because of weak snowpack conditions, and the fact that a large avalanche, similar to the event that resulted in the death of Jesse Williams, had occurred in an adjacent area on the previous day, and that The Canyons had not taken the proper steps to make the area safe prior to opening. This trial was of considerable importance to the ski industry, as for some time an industry goal was to have avalanches considered to be one of the inherent risks of skiing. It also challenged the widely held beliefs that the results of explosives testing provides an accurate assessment of snowpack stability, and that those results can and should be used in determining whether to open avalanche-prone terrain to the public.



Three scales of view of the Red Pine terrain.

Snowpack analysis is one of the cornerstones of avalanche forecasting, and to not have an intimate understanding of snowpack conditions in one's area of responsibility is unthinkable. But it is reasonably safe to say that if ski areas throughout North America relied solely on snow pit observations to determine whether or not to open terrain, many resorts would keep much of their areas closed much of the time. But this is not the case. Large amounts of terrain are safely opened to the public every ski season, often when weak layers are present in the snowpack. This is possible because of the systematic and proper use of explosives to test snowpack stability. There are more than 100,000 explosive charges used annually to test snowpack stability in US ski areas. There may be as many as 10,000 avalanches that occur annually in those ski areas, most of which are the result of explosive tests. This means that approximately 90% of the time explosives fail to produce an avalanche. The lack of avalanche activity suggests the area is "reasonably safe" and it is then usually opened to the public. Perhaps 10 times a year, a slope that has been tested with explosives, with negative results, subsequently avalanches in an event triggered by a skier or snowboarder. One can determine from this that explosives work most of the time (99.99%), as an adequate test of snowpack stability as it relates to the additional load of a skier. But they don't work 100% of the time. The Expert Witness for the Plaintiff contended that the lack of avalanche activity from explosives tests in an area known to have a weak snowpack, along with the deep-slab avalanche that occurred on an adjacent slope the previous day, required that the area remain closed until an avalanche could be initiated, or until snowpack analysis suggested that stability had improved naturally. Would this approach further reduce the small number of "post-control avalanches" that occur? Could it completely eliminate them? Could ski areas operate under these restrictions? And, would the skiing public accept this extremely conservative approach?

It is difficult to candidly discuss the "art/science" of avalanche forecasting and control in a court of law. Anyone who has watched a courtroom scene on TV understands the relentless questioning by plaintiff's attorneys, looking for an opportunity to make a point, to catch a witness off guard, to highlight a vague assumption, or to uncover inconsistencies on the part of those testifying. By doing so they hope to convince the jury that mistakes were made, or that someone was at fault. Unfortunately, there are few disciplines that have more inconsistencies, assumptions and vagaries than avalanche forecasting and control. Because of these concerns, one has to be very careful what one says while being questioned, and that means that sometimes you can't accurately express what you really mean or think. You can't express any doubt that those you are representing could or should have done anything other than what they did, and you can't admit to the fact that some degree of uncertainty accompanies many of the decisions avalanche workers regularly have to make.

The defense built their case around the idea that the ski area had done all it could to prevent this accident from happening. They observed snowpack structure, they monitored the weather, they carried out thorough explosives testing, using more charges than usual in response to snowpack conditions and to the fact that

a large avalanche had occurred on an adjacent slope, and they posted warnings of potential hazards. The defense also highlighted the fact that the area had been open the previous day, without incident. But their case was complicated by the fact that no pre-season, boot-packing had been carried out in the Red Pine Chute area (The Canyons Snow Safety Plan stated that "ski and/or boot compacting of starting zones is done as soon as snow accumulates on the ground") and, that there had been a limited use of "air-blasts" in the Red Pine Chute area prior to opening.

It is not difficult to criticize or to find fault with efforts taken to prevent an avalanche accident, after the accident has occurred. It's easy to point out that there is always something more that could have been done; one more shot, one more ski-cut, one more day of leaving the area closed. Avalanche workers don't have the benefit of seeing into the future. Expert witnesses have the benefit of looking back at the past. On the other hand, avalanche professionals must do everything necessary and reasonable to prevent tragic events such as this from happening. But the unfortunate truth is that post-control avalanches cannot be completely eliminated. The job of ski area avalanche workers is to determine when it is reasonable to open an area to the public, to use accepted industry standards to make those determinations, and when it is felt that all has been done that can or should be done, the area is opened. Are any of us involved in difficult decisions of this type ever 100% certain that a post-control avalanche will not occur?

[Are any of us involved in difficult decisions of this type ever 100% certain that a post-control avalanche will not occur?

Our collective understanding of snow and avalanches is not what we wish it could be. But is it enough to allow us to decide when the public can access steep, potentially dangerous terrain that we have tried to make "safe?" The public demands powder skiing in avalanche-prone areas, but what is their understanding of the small but residual risk that cannot be eliminated? What is their understanding of the uncertainty that may have surrounded the decision that allowed them the opportunity to experience the thrills they are seeking?

After eight days of testimony from ski area employees, friends and family of the deceased, and expert witnesses, it took the jury only 45 minutes to decide the case in favor of The Canyons Resort. Jury members concluded that the ski area had taken reasonable measures to prevent this accident from occurring, and, that they had adequately warned the public of the risks of skiing in steep, avalanche-prone terrain. The jury evidently felt that avalanches are one of the Inherent Risks of Skiing, and are not 100% preventable, in spite of the industry's best efforts. It is quite possible that this case will set a precedent for lawsuits of this nature in the future.

What can we take away from all this? For one, we know that it is difficult to convey the nuances and complexities of avalanche forecasting and control to a judge and jury, especially under cross examination, but that it can be done. Another more important fact, and something that all avalanche workers already understood, is that skiing can be a dangerous sport. Avalanches are difficult to predict, and that in spite of our best efforts, avalanche-prone terrain in developed ski areas cannot be made 100% safe. Post-Control avalanches will continue to plague us, avalanche workers will continue to be caught, injured, or worse, while doing avalanche control work, and occasionally members of the public will also be injured or perhaps killed, in areas that others had considered to be "reasonably safe." It is essential that we be the best we can be at our jobs, we need to stay focused, to spend most of our time on the snow, in all kinds of weather, and to be very thorough in our avalanche mitigation efforts. We need be aware of the conditions that have led to other post-control avalanches, and do what is necessary to help prevent as many of them as we can. And it's important that if you include something in your operations or safety plan, you make sure that it gets done. But it's also important for the skiing public to consider the fact that skiing in avalanche terrain can be hazardous, in spite of the fact that it's taking place within the boundaries of a developed ski area. Skiing fast, or hucking off cliffs are perceptible hazards, ones that pose obvious risks which we can choose to accept or not. In skiing avalanche terrain, most of the skiing public probably doesn't consider what the underlying snowpack layers are, or what the avalanche activity has been on surrounding slopes, but maybe they should. Would this increased awareness have prevented this tragic accident, who knows? Jesse Williams was a part-time patroller at a resort in Colorado, maybe he was thinking of these things, but the accident happened anyway.

This trial, like the Alpine Meadows trial, highlighted the difficulties of dealing with avalanches in developed ski areas. In both cases, the defense prevailed. But in spite of the courtroom victories, I imagine that avalanche workers from both resorts feel that in some ways it was a loss. In both cases, the avalanche, their adversary, won, and their goal of making the mountain safe was not realized. Perhaps there is some comfort in knowing that if we try to do the best we can, that those efforts may be acknowledged. But we will continue, at times to be bested. We must do our best to prevent avalanche accidents from happening, but be prepared to defend our actions, when the next tragic accident occurs. ❄

Topo view of the Red Pine terrain, with the chute delineated in black.

Lessons Learned

Some perspective on Red Pine Chutes Accident

Story by Jake Hutchinson

"Did you hear? Max graduated from high school this spring!" It brought a smile to my face. When I first met Max he was a lifeless 11-year-old boy with no pulse and no respirations after being buried at least thirty-nine minutes in an avalanche. Now after a jury trial and almost seven years of nearly daily reflection on the events of the December 23rd, 2007 avalanche accident at Canyons Resort in Park City, Utah, there is a bright spot and some clarity on crucial practices in our unpredictable work environment.

Do your job and do it well. We work in an incredibly challenging and dynamic environment. None of us has the tools or abilities to know exactly what the snow and weather will do, so you have to stay diligent to the constant changes and learn from your history, be ready to change on the fly as the avalanche conditions dictate, and then be prepared to explain why you did or didn't deviate from the plan of the day.

Have good written policy and procedure. Allow for the flexibility of changes or judgment calls based on the facts and the conditions at hand. Our work environment makes predicting every possible scenario impossible, and especially difficult to outline in a rigid set of words and documents. Focus instead guidelines and best practices. Good signage that is well maintained is important too. The sign means nothing if it's covered in rime, knocked over in the snow or otherwise unreadable.

Have a good Critical Incident Debrief program. I've been involved in more traumatic events in my career than I care remember. For the most part I've been left unscathed. I didn't realize the impact Red Pine Chutes had on my life and well being until a few minutes after I heard the jury verdict. I was carrying a lot inside and dealing with it poorly or not at all. The local well-intentioned doctor moderating a beer drinking/venting session isn't a debrief plan. There are plenty of good, local resources in almost every town. Use them.

Organized rescue works. I trained it, I taught it, and I never thought I would see it work, but it did. A rookie ski patroller took a bundle of probes and a group of teenage girls who were on scene, gave them a 30-second "how to" and then made a positive strike. If he hadn't been trained pre-season, I don't think we would've had the same outcome. Which brings back something I was taught in the Marine Corps: "Train like you fight" if you are apathetic, bored and just going through the motions when you're training then you may not be as proficient as you'd like when it's go time.

Surround yourself with good people. Having the best people you can find, having faith in them, giving them tools and opportunity to succeed and then pushing them to constantly be better allows you to have confidence in the work they do and the decisions they make.

These reflections only scratch the surface. I could go on forever about what I learned and how it affected me. This event certainly impacted and changed my life on multiple levels. Waiting for a jury to decide if I was negligent in my job and my decision-making process was the longest 45 minutes of my life I think. As is human nature, I second guessed myself, wondered if I missed a clue or could've/should've done something different based on what I knew at the time and every time my answer was no. We made the best decisions we could have based on what we were seeing and what we had seen on that slope over the previous ten seasons. There isn't a day that goes by that I don't feel sad for the Williams family, but I try and focus on Max and celebrate the life we saved. ❄

Jake Hutchinson was snow safety director at the Canyons from 1998-2003 and patrol director from 2003-2011. Now he teaches avalanche education for AAI and is the Certified Instuctor rep to the AAA board.

RUSSIA | JAPAN

Snow avalanche disasters at islands disputed between Russia and Japan

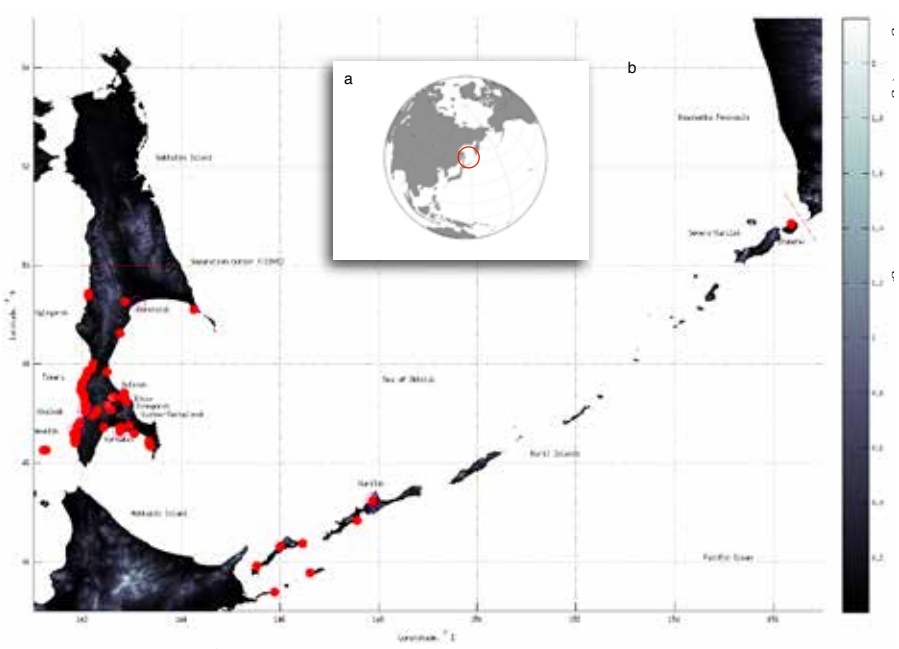
Story by Evgeny A. Podolskiy, IRSTEA, UR ETNA, France

Researchers from France (IRSTEA), Japan and Russia discover that the islands disputed between Russia and Japan share a tragic history of encounters with snow avalanche disasters, and that Sakhalin and the Kuril Islands make up the world's deadliest avalanche-prone region.

The record of snow avalanche disasters on far-east Sakhalin and the Kuril Islands has always been incomplete due to the historical divide of the region between Japan and Russia. This divide and the continuing territorial dispute (one of the most significant factors in the continuing absence of a post-World War II peace treaty between Russia and Japan) has produced a split in data about snow avalanche incidents, with an impact on disaster mitigation in the region. The analysis of such historical avalanche data is of essential importance when developing accurate hazard maps, particularly in the light of the intense colonization of the islands during the 20th Century.

About a year ago, I was reviewing the Ph.D. dissertation of my Russian colleague, Dr. Vladimir E. Suchkov (now at Avalanche Safety Service, Olympic "Roza Hutor" Ski Resort, Sochi), who mentioned in his thesis that absolutely nothing was known about any snow avalanches that occurred during the Japanese era of Sakhalin and the Kuril Islands. I wondered if this was true. Could there be some old records for the first half of the century that were conserved after repatriation of Japanese from Sakhalin back to Japan following the end of the second World War? Following this hunch, I wrote to my previous Japanese colleagues for help and advice, and quickly found out that Dr. Kaoru Izumi, professor of Niigata University, had been collecting old newspaper articles about Japanese avalanche incidents, including Japanese newspapers published at Sakhalin before 1945. This unique, laboriously collected archive material became an invaluable source of crucial historical and statistical information, which made the study possible.

My co-authors and I, including Dr. Nicolas Eckert, a statistician from IRSTEA, combined and analyzed all available relevant information from Japanese and Russian archive sources in order to reconstruct a continuous record of avalanche catastrophes in the region from 1910 to 2010. Despite the relatively small scale of the majority of disastrous avalanches (with a total vertical drop less than 650 feet) the evidence documented in the paper places the region among the most avalanche-affected areas of the world. We found that in total, 756 fatalities and more than 238 injuries occurred in 275 incidents during 100 years. Two thirds of the fatalities and incidents were Japanese and, probably, Koreans. This death toll is higher than that of Canada, New Zealand, Iceland, or non-recreational fatalities in France. Reconstruction of records places the islands' per capita avalanche casualty rate among the highest in the world (together with Switzerland, Austria, Iceland and Norway). Furthermore, it highlights the crucial importance of small avalanches (like those studied by my research unit, ETNA, at Col du Lautaret, in French Alps) since they may produce the deadliest avalanche terrains of the world.

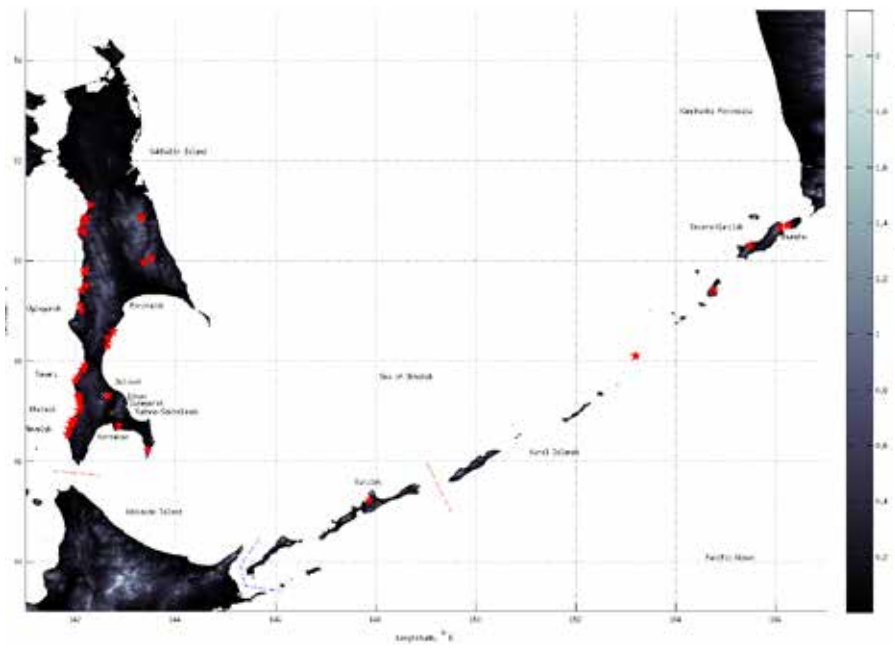


(a) The location of Sakhalin and the Kuril Islands.
(b) Map with approximate locations of all known avalanche incidents occurring between 1910 and 1945 in the Japanese parts of Sakhalin and the Kuril Islands. Color bar for elevations is shown in kilometers. Pink empty circles indicate locations of old Japanese meteorological stations.Red solid and dashed segments indicate maximum extent of Japanese borders.

Moreover, an association between high catastrophe rates and the most intense phase of colonization of the islands (1930s–60s) could be shown. This means that the most intense growth and development of population were associated with the highest number of avalanche disasters, thus illustrating the risks involved when new societies migrate to unfamiliar mountain territories. Although this demonstrated `wave' of disasters could be considered a local issue of the past, many presently developing countries may face similar impacts. Furthermore, the article suggests that devastating deforestation of Sakhalin could have played a role in a high number of avalanche incidents in the first half of the 20th century.

In addition to scientific interest, the importance of the recovery of old Japanese records about previous avalanches could, like the discovery of a map for land-mine fields, be used to ensure a safer life for people living and visiting the region. As it was widely publicized recently after the tsunami in Japan, 11 March 2011, such a piece of historical information, if overlooked, may cost many lives. Accordingly, collection and assimilation of the data partly introduced and covered in our paper, together with its further analysis and understanding can contribute to natural hazard assessment and mitigation for the sustainable development of the region.

I anticipate our case study to inspire new interest in territories with a 'shattered' political history, which could bring together scientists from opposite sides to help test hypotheses and illuminate trends in various disciplines, otherwise 'invisible' due to non-continuous data. After all, natural hazards, like snow avalanches, do not have any respect to nationalities or conflicts between nations, which should be overcome for the common good.

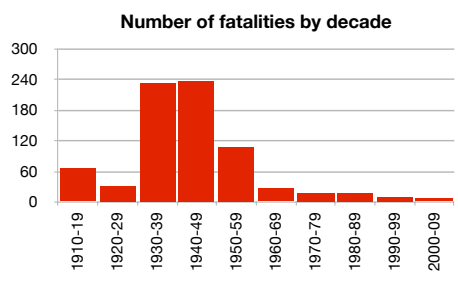


Map with locations of all known avalanche fatalities occurring between1928 and 2010 in the Soviet/Russian parts of Sakhalin and the Kuril Islands. (Blue dashed segments indicate the sea border between Russia and Japan according to Russia; red segments further northeast are the border according to Japan.)

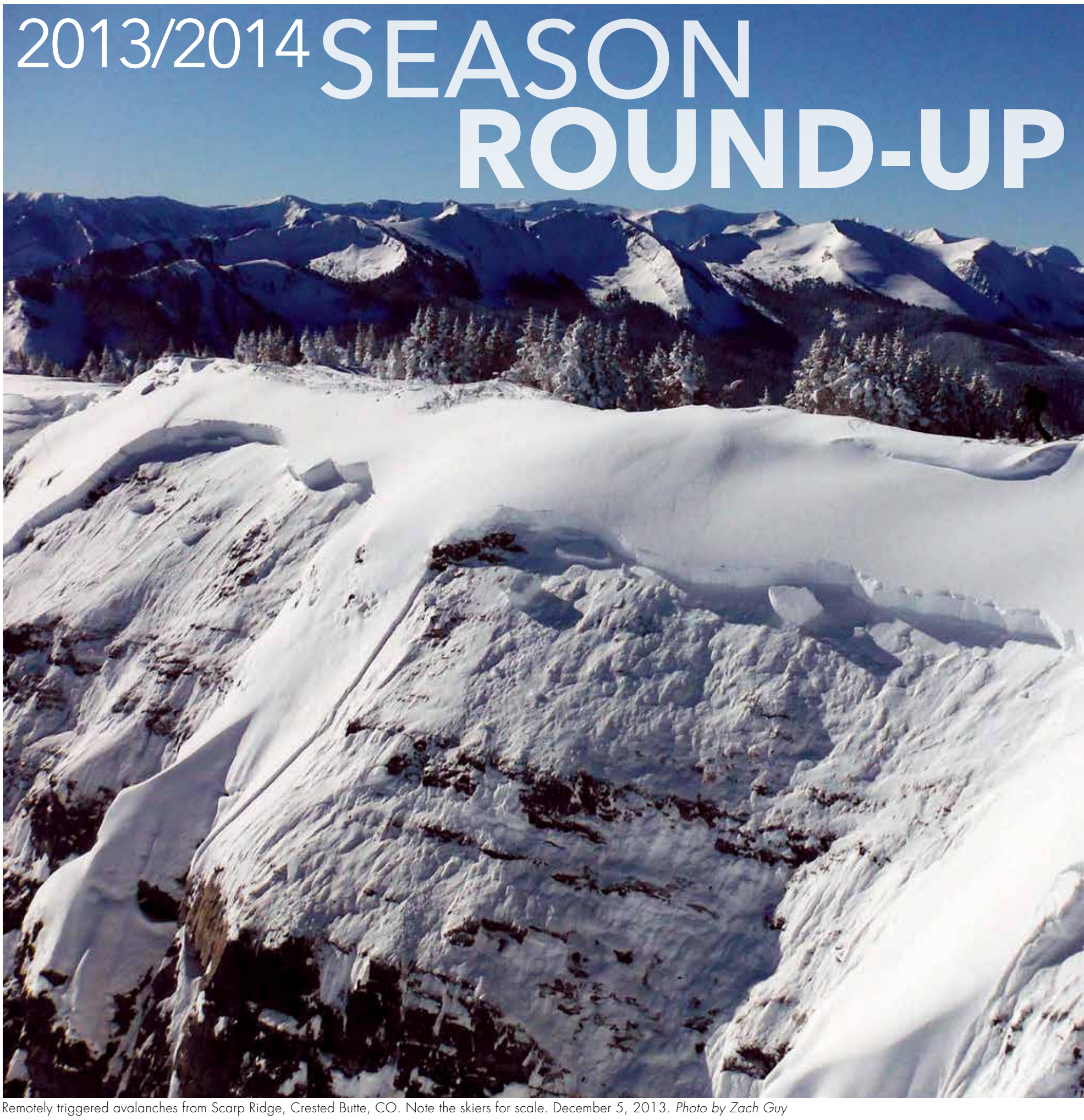
Paper

Podolskiy, E.A., K. Izumi, V. E. Suchkov, and N. Eckert (2014). Physical and societal statistics for a century of snow avalanche hazards on Sakhalin and the Kuril Islands (1910-2010), Journal of Glaciology, 60(221), 409–430, doi:10.3189/2014JoG13J143, \ www.igsoc.org/journal/60/221/t13J143.html

Evgeny A. Podolskiy, who completed his Ph.D. in Japan and has spent time on Sakhalin for an internship, at the moment works as Marie Curie Research Fellow with snow-avalanche group of IRSTEA institute in Grenoble, France. He can be contacted at evgeniy.podolskiy@gmail.com.



2013/2014 SEASON ROUND-UP



Remotely triggered avalanches from Scarp Ridge, Crested Butte, CO. Note the skiers for scale. December 5, 2013. *Photo by Zach Guy*

NATIONAL AVALANCHE CENTER

NAC — The 2013/14 winter sharply delineated the 'haves' from the 'have nots'. For California skiers, water supply managers, and now fire fighters, this season will be remembered as historically dry. In some areas, mountain biking on dusty trails in January replaced mid-season powder turns. However, farther west in Montana, Wyoming, and Colorado, skiers and snowmobilers found themselves happily riding new snow all season long. Cooke City, Montana recorded new snowfall for 43 straight days totaling more than 20 feet during that period alone.

Nationally, our first avalanche fatality occurred in late December. Unfortunately, the death toll quickly and steadily mounted as impressive storms piled snow on early season weak layers. February was especially difficult, with 12 avalanche fatalities and several serious injuries and close calls. The season ended when six climbers killed in a slide on Mount Rainier in late May pushed the season total up to 35. While we all agree these numbers are unacceptably high, they would be much higher without the great work of the avalanche centers featured in this issue of TAR.

The past season was another short-handed and transitional one for the Forest Service National Avalanche Center (NAC). Luckily, I was able to bring Denny Hogan on board on a temporary basis for the winter. Denny was a huge help, troubleshooting problems within our avalanche center network and working on a variety of issues related to both the centers and the artillery program. His assistance was sorely needed, and it allowed me a level of sanity that I had not experienced at work in the nearly three years since the late Doug Abromeit retired. By the end of the year the wheels were finally firmly in motion to permanently fill the vacant NAC position. Denny was in the process of retiring, but thankfully he was able to assist with getting the position filled prior to his departure.

The NAC vacancy attracted a number of top tier candidates, and from that group Simon Trautman was selected (see Metamorphism section, page 3 of this TAR). Simon hit the ground running at the start of July, and he and I have been hard at work on a wide range of issues related to the Forest Service avalanche program. In addition to our usual duties supporting the avalanche center and military artillery programs, we have been working on updating and modernizing the NAC website, writing a number of papers and preparing presentations for the upcoming ISSW, following up on last summer's operational safety project with avalanche center directors, and utilizing spare funding to fill some critical safety needs at various avalanche centers. In addition, we were able to fund Andy Anderson from the Sierra Avalanche Center to work on a mobile application that will push avalanche advisories to use mobile devices, receive and distribute observations (to respective avalanche centers) from those using the app, and will be free to the public and avalanche centers alike.

While future overall government funding appears flat or dwindling, I am heartened that our avalanche centers continue to get relatively stable (or, in some cases, increasing) base funding from their funding agencies, as well as increasingly important funding from Friends groups and other partners. Improving public safety is truly a team effort, and that effort includes almost everyone in the avalanche industry. Whether you are a guide, a ski patroller, an educator, or a forecaster, it is likely that you provide observations and other critically important support and services to our avalanche centers. Thanks for everything! I'd also like to give a big shout out to Wendy Wagner from the Chugach National Forest Avalanche Center, who worked with Lynne to get these summaries submitted. With that, I'll hand this issue of TAR over to the season summaries from the individual centers. ⁂

—Karl Birkeland, Director of the NAC

CBAC — Year in Review: The Evolution of the Deep Slab Problem

Following impressive early season snowfall, a November dry spell capped by a major snow and wind event established the brick-over-potato-chips foundations for the rest of our season to build upon. This plaguing facet layer was already rearing its ugly face on our first advisory on November 27, and our forecasters were blessed with opportunity of describing persistent weak layers in almost all of our 138 daily advisories of the season. By the time most folks had exchanged their skis for mountain bikes or kayaks in June, we were still observing full depth wet slab avalanches, most likely on this same layer.

Unsettled weather through December and into January brought a series of storms, several relatively mild avalanche cycles, and allowed more crust and facet layers to form between storms. The monsters in the basement were active early (see photo above), but had become fairly stubborn by the New Year. A sustained snowy period in early January brought up to 4.0" of SWE with extreme winds at its tail, flushing new snow instabilities and prying out a handful of deeper slabs. Two weeks of "Juneuary" followed, with mild and sunny days, abnormally low danger, and fresh layers of crusts and facets in the making.

The highlight of the season came barreling into the Elk Mountains beginning on January 30. It started with a huge hit of up to 4.0" of SWE in just 60 hours accompanied by extreme gusts. We had a brief clearing on February 2 which gave us a good view of widespread storm snow avalanches. For such an impressive load, we were surprised that nothing failed on deeper layers.

Modest snowfall and winds continued until the Pacific river of moisture found a bull's-eye over Crested Butte on February 7. 3.5" of SWE walloped the mountains over the next three days as winds increased. When the storm cleared on February 10, one third of the entire season's snowfall to date had fallen in just 12 days. Schofield Pass reached 9.5" of SWE; one of the largest storms that site has seen since it was installed 30 years ago.

The tail end of the storm produced utter carnage. Dozens of full-depth, full-track avalanches littered the landscape. Local roads were covered in debris. Slides widened historic runouts and impacted structures. One crown was over a mile wide and several were over 10 feet deep. See the centerfold of TAR 32-4 for images from this avalanche cycle. Sadly, a snowmobiler was buried on February 10 along Kebler Pass Road, our only fatality of the season.

Spooky deep slabs continued to fail daily into mid-February as temperatures climbed, winds increased, and small amounts of rain and snow fell. Less than 1.5" of SWE fell in the last two weeks of February, but the snowpack was slow to decompress. Cornice falls, continued windloading, and a large storm at the start of March all triggered a few more deep slabs naturally. Their timing was becoming sporadic and less predictable, but a tranquil storm track in March began to ease our deep slab concerns. Spring-like weather arrived seemingly uneventfully for two days in mid-March. However, a few days later, three more unnerving deep slabs released under relatively cool and benign weather (see photo on below).

The last significant storm of our forecast season came in late March, delivering up to 3" of SWE under the strongest winds of the season (gusts up to 110 mph). This was the only significant storm of the entire winter that didn't produce deeper failures. Unfortunately, it was accompanied by two major dust events that would diminish the quality of spring skiing and paint our mountains red going into summer.

Investigating the crown of a natural deep slab on Mt. Owen that ran around March 11 on a January crust/facet layer that was buried up to 12 feet deep. *Photo by Zach Guy*

Our center closed for the season on April 13 as spring thaw triggered a few full-depth wet slabs failing at lower elevations. However, it wasn't until the last week of May that melting peaked and brought another wet slab cycle. Over six months since these layers were buried, they were still producing full depth slab avalanches at high elevation northerly aspects!

Successes, Challenges, and Deep Persistent Thoughts for the 2013-2104 Season — Our forecast team used a multi-faceted approach (pun intended) to reach the public and ward off message fatigue by using photos, videos, blog and Facebook posts, trailhead days, and more. We received a lot of positive feedback from the community for using creative or humorous analogies in our bulletins. Comparisons to TPS reports, first kisses, work-place flatulence, and more kept our advisories from becoming too stale with tiresome deep slab concerns. For example, our Valentine's Day advisory concluded with: "Gentlemen, deep slabs are like your girlfriend or wife today. Give them the special consideration and time they deserve by carefully choosing your terrain and being patient with our snowpack. If you neglect them or forget about them today, you may find yourself getting pummeled by an angry dragon in a struggle to stay afloat."

> Gentlemen, deep slabs are like your girlfriend or wife today. Give them the special consideration and time they deserve by carefully choosing your terrain and being patient with our snowpack.
>
> —*CBAC Valentine's Day Forecast*

This winter, the deep slab problem presented a few real head-scratchers. A forecaster from a neighboring zone characterized the challenges well during our February cycle: "This last week was memorable for me. A real highlight in my career. I still can't fully explain some of the slides and conditions I saw. Not many other fields, even in the physical sciences, [have] dramatic events happen and leave you scratching your head or muttering 'Wait, WTF just happened.'" Questions of warming, mechanics, and critical loads will linger into seasons to come.

A common discussion amongst our forecast team is whether you can have low danger with deep slab structure. This came into play in the spring when the deep slab problem was very stubborn and human triggering was very unlikely if not impossible, but the threat of an unpredictable cornice fall might be enough to bring down an entire slope. Does very low likelihood ever trump very large size on the danger scale?

Although snowfall amounts this winter came in only slightly above average, it was a memorable winter from an avalanche perspective! ❄

—Zach Guy, CBAC director

NORTHWEST AVALANCHE CENTER

(continued from cover) **NWAC — 2013-2014 Weather Summary —** Winter had a slow start in December. Not all of the Northwest ski areas were open by Christmas and NWAC winter forecasting began later than usual on 11 December. Finally a storm cycle the first half of January brought 4-6 feet of snowfall at NWAC sites near the Cascade crest in a 10-day period.

As many know, a ridge afflicted much of the western US and Canada from mid-January to mid-February. Dry weather and warm temperatures were seen in our area the second half of January. The freezing level at Forks on the Washington coast averaged over 9000 feet the entire second half of January. This generally caused a crust layer to form throughout the Northwest.

Early February turned cold but remained generally dry. This caused surface hoar and faceted snow to develop into persistent weak layers near the crest in the Washington Cascades, where total snow depths were running about 60% of normal at NWAC sites in early February.

Winter returned with a vengeance in late February. A storm cycle from about 11-25 February delivered about 8-12 feet of snowfall and activated the persistent weak layers. We issued the first avalanche warning of the season for 11 February.

We had a very active late winter. Three fairly distinct storm cycles were seen in early, mid and late March. Each cycle brought snowfall in the two to four foot range with the persistent weak layers remaining active. By the end of March total snow depths were back to normal. About four more storm cycles were seen from mid-April to early May. These cycles were remarkable for the amounts of water equivalent which were in the two to eight inch range for each cycle at NWAC sites near the crest. Each cycle was also good for anywhere from a few to 50 inches of snowfall which tended to be heaviest at Mt Hood.

Late January – Early February Persistent Weak Layers – These layers were a problem in the Northwest for much of the second half of the winter which we were continually addressing via our new professional observers, you tube videos and avalanche forecasts. Although avalanches were triggered due to these layers they did not cause any fatalities. We have anecdotal evidence that people were changing their travel plans due to forecasts and information about these layers.

Accidents — We had 3 fatalities in 3 separate accidents (Lewis Peak, Granite Mountain, Mt Shuksan) within our forecast area this season. There were several other accidents with serious injuries. At the end of May, 6 climbers were killed high on Liberty Ridge of Mt Rainier in what may have been an avalanche but the official cause has not yet been determined. Please see the accidents page of our website (www.nwac.us) for further information.

NWAC becomes NWAC — We changed our official name back to the Northwest Avalanche Center. We think it has a better ring to it. We were the Northwest Weather and Avalanche Center from 1997 through last season.

Merging of the Friends of the NWAC and the NWAC — In order to reduce confusion between the forecast office and the non-profit side we are now presenting both organizations as the NWAC. However, financially and for tax purposes the organizations remain distinct.

New Logo — We had Hammerquist Studios of Seattle develop a new logo for us.

Web Site — Last fall, for the third time in the last few years, we redesigned our web site. We left behind the avalanche danger rose and adopted the CAC and the CAIC system of avalanche concerns/problems and Tier 1 through 3 information layers. A few folks let us know they missed the danger rose but most said they liked the new system.

New Pro Observers Program — This season we launched the Professional Observers Program. Six observers were hired for five forecast zones: Olympic Mountains (half-time), Mt. Baker Area, Cascade East Side North, Cascade East Side South (including Mt. Hood), and the Seattle area. The program operated from December to April with each zone receiving an average of three observations per week.

In addition to the detailed information given to the forecasters, the observers provided social media. Observers submitted 44 videos to the NWAC YouTube channel with a seasonal view total of 35,300 - one video illustrating a very sensitive buried surface hoar layer was viewed about 13,400 times. This video, along with satellite-pushed Twitter posts from the field, helped augment traditional forecasting and we feel greatly contributed to a fatality-free February - in spite of the late January/early February persistent weak layers.

Education — This season, we conducted over 125 public awareness classes and lectures which reached over 5000 people, almost twice as many as last year. Eleven of these classes were snowmobile specific events and we have an increased focus on youth.

This season is the third year of our partnership with the American Institute of Avalanche Research and Education (AIARE). The NWAC - AIARE Avalanche Awareness Program is offered as a public service to communities, schools and outdoor clubs free of charge. Program length is around one and a half hours.

Going Deep Program — In addition to our public awareness classes, we continued our program called Going Deep, targeting experienced backcountry skiers and riders, and addressing some of the limitations of awareness classes and conventional avalanche education when it comes to decision-making. The series of four classes was a great success with 50-100 attending each session and we will be conducting a similar series next season.

 # 1: *Everything You Ever Wanted to Know About Avalanche Forecasting (But Were Afraid to Ask):* An Evening with the Staff of the Northwest Avalanche Center

 # 2: *Biases, Shortcuts, and Outcomes:* Training Your Brain to Make Better Decisions in the Backcountry-An evening with Margaret Wheeler

 # 3: *Deconstruction Decisions in a High Risk Environment:* A Close Look at Previous Decisions Made —An Evening with Roger Strong and Crew

 # 4: *Making the Transition from Winter to Spring:* How to Plan Big Lines and Multiday Tours Without a Daily NWAC Avalanche Forecast — An Evening with NWAC & Special Guests

Please see our annual report when it becomes available on our web site for further information.

—Garth Ferber, NWAC forecaster

COLORADO AVALANCHE INFORMATION CENTER

CAIC — The Colorado Avalanche Information Center hired three new backcountry forecasters for the 2013-14 avalanche season. Blase Reardon moved south from Idaho to take over the Aspen and Grand Mesa zones, Rebecca 'Becs' Hodgetts was enticed away from her long-term working relationship with Arapahoe Basin ski area to cover the Vail/Summit County and Sawatch zones, and Josh Hirschberg took over forecasting for the North and South San Juan zones. All three forecasters did a great job during a challenging season.

The CAIC also launched a new web site relying more on graphical elements to describe the avalanche danger and avalanche problems. The new design was a transition from the more text-based products of previous years, and it took the forecasters a short time to get acquainted with the new communication tools. Change is always hard and although there was a little grumbling, feedback from the public was overwhelmingly positive. We are working on small improvements for the fall.

The avalanche season got going in early October when Art Judson, former director of the Colorado Avalanche Warning Center, reported the first avalanche of the season on October 4, 2013. A small soft slab released naturally on the landing track of the 60 meter jump at Howelson Hill near Steamboat Springs. Observers reported 20 avalanches during October alone, including an incident on October 30 when three people were caught in two separate avalanches in the North San Juan Mountains. It was a taste of things to come as the 2013-14 season kept us on our toes through the end of May.

Fifteen incidents occurred from November 1 through December 27, including a very close call on December 27 when a telemark skier exited the Loveland Basin Ski Area into an area known as the Mine Dumps. The skier was caught in a small avalanche and was buried with only the tip of his ski pole above the snow. A snowboarder witnessed the incident and was able to traverse to the debris pile. The snowboarder did a beacon search but didn't find a signal. The snowboarder began a quick search of the debris pile and saw the ski pole sticking out of the snow. He found the skier using his probe pole, about 3 feet under the snow. The skier did not have a beacon, but bought one on his way home after being extricated alive.

A large avalanche in the East Vail Chutes that caught three riders and killed one on January 7, 2014. *Photo Courtesy of the CAIC*

2013 ended on a sad note. On December 31, the first avalanche fatality of the season occurred on Parkview Peak just off the Continental Divide in the Steamboat zone. A snowboarder triggered a hard slab avalanche that carried him 20 meters downhill and buried him against a small tree. His partners used beacons, probes, and shovels to quickly find and extricate him. Their attempts to revive him were unsuccessful. Tragedy struck again in the first week of 2014. On January 7, four backcountry riders were caught in a D3 hard-slab avalanche in the East Vail Chutes. One skier was killed in the accident, and one snowboarder was injured.

More than half of Colorado's eight avalanche fatalities for the season took place in the short window from February 10 to March 5. This time period saw two storms, each dropping more than 4 inches of water in parts of the state. The huge loading events on persistent weak layers produced some very large and deadly avalanches. On February 10, helicopter mitigation work for the Colorado Department of Transportation triggered a R3 D3 hard-slab avalanche that took out significant timber before hitting US Highway 6 on Loveland Pass. The same day two separate avalanches caught four people and killed two. Two backcountry skiers were caught in a D3 hard-slab avalanche south of Keystone in Summit County, and one skier was killed. On Kebler Pass outside Crested Butte two snowmobilers were caught and one was killed in a large storm-slab avalanche. On February 15, five backcountry riders were caught, three buried and two killed in a R4 D4 avalanche on Star Mountain A, an avalanche path that can hit Colorado Highway 82 west of Twin Lakes.

The last two avalanche fatalities of the season ran the first week in March. On March 4, Colin Sutton, the snow safety director at Wolf Creek Ski Area was killed in a R3D3 hard-slab avalanche on Diablo Ridge, near Conejos Peak in the South San Juan Mountains. Three other Wolf Creek Ski Patrollers were able to quickly locate and dig Colin out of the avalanche debris, but could not resuscitate him. On March 5, a group of snowmobilers was high-marking on Sharkstooth Peak in the La Plata Mountains northeast of Durango. One snowmobiler was caught in a

Looking up the gulley runout of a large avalanche near Conejos Peak that caught and killed Colin Sutton, the snow safety director at Wolf Creek Ski Area on March 4, 2014. The flowing debris gouged the deep side walls. *Photo Courtesy of the CAIC*

R2D2 avalanche. Due to the exposed location of the burial site, and over 10 meters of avalanche debris, the victim was not recovered until early June.

On March 31, an Avalauncher round exploded in the breech of the launcher while conducting mitigation work on U.S. Hwy 6 over Loveland Pass. The explosion seriously injured a Colorado Department of Transportation gunner and a CAIC avalanche forecaster. Shrapnel from the explosion flew several hundred feet away from the destroyed truck and gun mount. We are very lucky that all involved members of the gun crew survived. This is an accident that could easily have been much worse.

Winter conditions held on well into spring, and storm cycles were hitting the state every two to three days through mid-May. A wet slab cycle began in early May and progressed around the compass and up in elevation as the month wore on. The cycle had finally made its way to high-elevation north-facing slopes as we issued our last statewide avalanche forecast on June 3. Avalanches caught at least 83 people and killed eight people in Colorado during the 2013-14 season. The number of fatal accidents is two more than the state's 10-year running average. ❄

Avalanches triggered by the Colorado Department of Transportation on February 11, 2014 above US 6 over Loveland Pass. *Photo Courtesy of the CAIC*

BRIDGER-TETON NATIONAL FOREST

BTAC — In Western Wyoming the 2013/14 season was characterized by repeated storm cycles and drought periods. An extended storm cycle that began in late January and ended in early March created historical avalanche events. The season ended with above average snowfall and a snowpack with a moisture content that was well above average.

Snow began to accumulate in the high country in late September. In October precipitation was above normal and temperatures were below normal. Snow storms in late September and early October were followed by a mid-October dry period and an end of the month storm cycle that continued into the first nine days of November. This scenario created a buried weak layer of faceted snow that would persist as a problem layer bed surface for the next four months.

On that last day of October strong winds increased the avalanche hazard. The first daily avalanche hazard bulletin was issued on the morning of November 1. This was also the date of the first avalanche accident. The second avalanche accident occurred ten days later. Both of these incidents involved skiers who were caught and seriously injured by avalanches that were triggered late in the day. Both involved wind slabs and the buried faceted layer that developed in October and required helicopter rescues from wilderness areas.

December 2013 began with record early season snow depths and a buried persistent weak layer that had already seriously injured two skiers. Large to very large (Class IV size) avalanches were explosively triggered by highway and ski area avalanche programs after a powerful storm impacted the region during the first week of the month. Record cold temperatures ensued. Conditions remained mostly dry until just before Christmas when a four day storm cycle brought significant snow to the region. Two separate avalanche events occurred on December 26 that resulted in the depth of a snowmobiler in the Snake River Range and a skier outside of the boundary of the Jackson Hole Mountain Resort. Both involved slab avalanches that released on faceted snow that formed earlier in the season.

The first four weeks of January were mostly dry except for one four-day storm cycle. A storm cycle that began at the end of the month continued through February and into March. This 40-day cycle brought over 200 inches of new snow with 24 inches of moisture to the mountains of Western Wyoming. Historic avalanche events (Class V sized) failed on buried weak layers and impacted local highways during this storm cycle. The third and final avalanche fatality of the season occurred on Angle Mountain near Togwotee Pass on February 18.

Spring began with a stable snowpack with near record amounts of moisture in our snowpack and snow depths that were well above average. Dryer conditions prevailed through June. Season snowfall totals ranged from 400 to 525 inches depending on location.

Daily avalanche advisories were issued continuously from November 1 to April 28. Weekly snowpack summaries were posted from late September through May. There were 1.5 million contacts to information provided by the Bridger-Teton National Forest Service Avalanche Center during this period.

A 2013 Recreational Trail Program grant (RTP) obtained in partnership with the Wyoming State Trails Program enabled the avalanche center to provide avalanche education presentations to communities in Wyoming as far as 450 miles from the avalanche center. This funding allowed the center to provide 16 new courses which were attended by over 500 people. These efforts were well received and this grant program is funded through the 2014/15 season.

Other tasks included a web-based national map project that posts the daily avalanche hazard for US avalanche center areas in a Google map format. Our goal is to expand the capability of this project to post avalanche watches, warnings and special avalanche bulletins for these areas when they are in effect during the 2014/15 season. Our 2013 RTP grant is also funding the development of a web-based pilot program that will enable the public to crowd source avalanche hazard information in a Google map format for areas that are not served by a local avalanche center.

New RTP grants are funding the replacement of the electronic components in the 17 remote automated weather stations operated by the center and will include the installation of web cams at selected stations. Our database of historical weather information will also be expanded over the summer to include data from the Togwotee Pass and Greys River forecast areas. ❄

—Bob Comey, BTAC director

This large snowmachine triggered avalanche occurred during a bout of Powder Fever caused by 5′ of snow in 5 days after months of bleak riding conditions. *Photo Mike Davis*

CHUGACH NATIONAL FOREST

CNFAIC — The 2013-2014 season saw the fourth consecutive year without an avalanche fatality on the Chugach National Forest. One might assume that being in a maritime snow climate would be a large part of this. However, this season's weather was far from typical for our region.

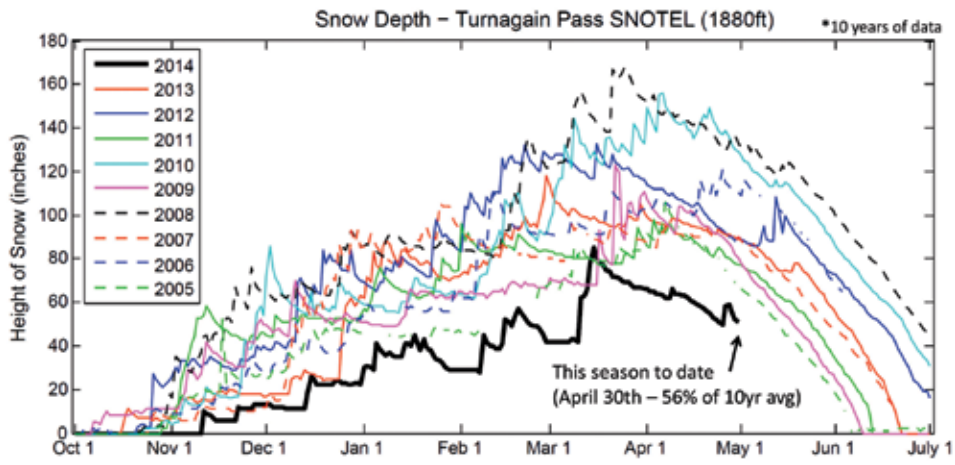
Winter Part I — Persistent slab instability and remotely triggered slides plagued the snowpack for the first third of the winter. Early January brought the first extensive avalanche cycles, with several close calls and one accident resulting in a dog fatality. This was also the period with the most activity, culminating in an extensive wet slab cycle as the result of an abnormally warm and wet 10-day stretch at the end of January (see TAR April 2014 article).

Winter Part II — At the end of this impressive cycle, we were left with a "crust" up to 80 cm thick in many places and snowline starting at around 1,000′ above sea level [Photo 1]. From this point on, instabilities were found no deeper than this crust. February brought several smaller storms that made a feeble attempt to cover the alders that typically disappear much earlier in the year. The end of February brought another, less severe warm up accompanied by light rain and the end of winter Part II.

Winter Part III — As many people turned their attention away from typical winter recreation, we were reminded what a true Alaskan storm can do. Close to 5′ of snow fell in as many days, providing a much needed refresh to the entire forecast area. Another cycle ensued, with widespread D3 and D4 slides observed. (see photo above) Fortunately, instabilities did not linger long. A 3+ week spell of clear weather and relatively cool temperatures brought joy to the people and moguls to the backcountry!

The final month of our operating season was a quiet one. A storm that dropped over a foot of dense snow at the end of the month paved the way for a close call on Tincan ridge.

Numbers — 53% of the average (1981-2010) SWE at the Turnagain Pass SNOTEL site at the end of April. Precipitation % was at 80 at this point in the season. Rain at or above this station elevation accounts for some of this 80%. This translated directly to a sub par season in terms of snow quality and powder gluttony.



Turnagain Pass's 2014 snowpack – notice the black line (last season's snow depth) just flirts with being the shallowest pack every day of the season for the past 10 years. *By Wendy Wagner*

172 total advisories. 150 for Turnagain pass region, 22 for Summit Lake.

740 people we connected with directly with through outreach and education events. School groups, avalanche courses, radio & TV programs, and free workshops are just some of the venues we've employed to spread the word.

271 observations submitted and posted. 106 of those were submitted by public observers. We have been impressed with the bump in quality of obs submitted by the public. Website changes on tap for next year will further refine the information gathering and sharing for our entire community.

9,714 Youtube views. We have made a concerted effort to increase the number of videos we post. Consistent praise has come from our viewers and we will continue to expand and improve this highly effective educational tool.

83 days. Number of total days the Turnagain Pass motorized side was open to snowmachines. This is down from 165 last year and 179 the year before. The motorized portion of our community is critical to our mission. It was challenging to consistently provide for sledders. We managed to introduce a free new rescue clinic mid season and have plans to offer this on a monthly basis in 2014/2015. We are appreciative and fortunate to have had 2 seasons now with a brand new loaner sled from local dealer AMDS and Ski Doo/BRP. With these high end machines we are able to cover huge areas and provide the public with more accurate and pertinent info. We also made a third annual appearance at Arctic Man, an event in the Eastern Alaska range that draws 10,000 people for a week in April. [Arctic Man photo?]

Knocking on wood as I write this, we have had no reports of people being buried or worse this year. While there were some injuries as a result of avalanches and slide for life conditions, the season ended up a successful one. ❄

—John Fitzgerald, CNFAC forecaster

EASTERN SIERRA AVALANCHE CENTER

ESAC — The 2013-2014 winter season started out with early promise, faltered, vapor locked, then sputtered at the end of January and early February. After the biggest storm of the season at the end of February, dry conditions returned until the end of March and again at the end of April when two small storms added a few inches of water to a dismal snowpack. In terms of seasonal snowfall, more snow fell during a multiday storm in December 2010 than the 404 cm (159 inches) that fell over the entire 2014 season. When a late February storm dropped 36 inches of snow and brought the snowpack to peak accumulation for the winter, some of the popular backcountry areas became skiable. There was a brief flurry of activity right after the storm, then widespread apathy returned and the number of backcountry users fell to a handful of dedicated skiers and riders. After three years of marginal snowpacks, many folks wondered if deep winter snowpacks would ever return to the Sierra.

Like a brick wall, a mass of high pressure air blocked Pacific winter storms from coming ashore in California, deflecting them up into Alaska and British Columbia, and even delivering rain and cold weather to the East Coast and the southern part of the country. Similar high-pressure zones pop up all the time during most winters, but they usually break down and allow rain in the Coast Ranges and snow to fall in the Sierra Nevada. This particular high pressure ridge was the same ridge that blocked storms last winter, 2012-2013, making it unprecedented in modern weather records.

For those of us who work in the snow, unusual weather patterns bring the opportunity to learn from atypical snow conditions. Meager early season snowfall in October and November created 30 cm of depth hoar- after an early December storm, two out of bounds skiers on Mammoth Mountain triggered two avalanches that failed on the October/November depth hoar.

After the December 7 storm, no snow fell until January 31- 62 long days. There wasn't a single rounded grain in the advisory area and lots of bare ground and rocks. Mild temperatures in January and weak January sun created a crust/facet sandwich at mid-elevations. Access to alpine terrain was difficult due to a little bit of snow between rocks in talus fields and alpine zones to make skiing or hiking time consuming and treacherous. Field work was discouraging- navigating over, around and through rocks looking for enough snow to dig a miniature snowpit. Measuring more than a shovel length of snow depth and linking a few turns was cause for celebration at the truck.

General snowpack information statements were issued from mid-December through January 30 because there wasn't enough snow to ski or avalanche. Other avalanche centers faced similar dry conditions but snow came around Christmas, just as the eastern Sierra was almost halfway through the two-month dry spell.

When 50 cm of snow fell at the end of January, the slab over depth hoar structure produced consistent fracture propagation in tests at mid to high elevations but surprisingly, no natural avalanches occurred. A few days later, a much advertised but disappointing atmospheric river event brought high snowlines and 30 cm of high density snow and several days of strong winds; not much snow by eastern Sierra standards but just enough loading to trigger a D4 avalanche that ran to the ground on depth hoar. Multiple crowns scattered across a steep rocky northeast facing slope pulled out all of the season's thin snowpack. One avalanche hit a small alpine lake, breaking up the lake ice, and traveling another hundred meters up the slope on the far side of the lake.

Later that week, five days after the snowfall ended, a large D4 and smaller D3 avalanches occurred on a steep high elevation slope south of the advisory area. Avalanches occurring days after snowfall are a very rare event and D4 avalanches are fairly uncommon events during the winter and are particularly surprising given the shallow snow cover.

February was the wettest month of the abbreviated season. Six inches of water arrived in three storms- not very much snow and certainly not the "drought-buster" we hoped for. The largest storm of the winter dropped 36" of snow and 4 inches of water at the end of February and early March, bringing the snowpack to maximum snow depth of 180 cm in the Mammoth Basin and 120 cm in the Rock Creek watershed south of Mammoth. The persistent depth hoar layer in alpine zones in the Mammoth Basin was now buried under a thick dense slab; within a week, depth hoar increased in density, lost sharp edges and became rounded faceted grains.

February 11 2014, D4 avalanche runout on the Mini-Pinner Couloir. *Photo Courtesy of ESAC*

The shallow snowpack in the Rock Creek basin was another story-instead of gaining strength as sun angles increased and days become longer, the depth hoar became more reactive in mid- March. Rock Creek is a narrow, north south trending valley surrounded by 13,000 to 14,000 ft. peaks that block Pacific storms from dropping the amount of snowfall seen in the Mammoth area. Cold air pooling, high elevation and shallower snowpacks in Rock Creek create intermountain and occasional continental snow climates. Avalanche danger problems and ratings are often different from the coastal transition zone snow climate of the Mammoth Lakes Basin.

The weak, continental snowpack in Rock Creek was the perfect setting for Ned Bair to collect field data for his work examining how test lengths affect propagation. Chains of depth hoar chains up to 6 mm were observed many times. The depth hoar layer was 20 to 30 cm thick and failed repeatedly in standard length ECT's and 2-meter beams. Even as snow was melting on more solar aspects at the end of March, depth hoar continued to fail in ECTs until April 10.

The snowpack in Rock Creek became isothermal after April 10. Given the snowpack structure and with liquid water reaching the weak layer, it seemed like a perfect setup for wet slab avalanches. But wet slabs did not appear- a lesson the snowpack delivers that reminds us that while we may know something about snow, we don't understand wet snow very well.

The last three dry winters taught me more about snow than three wet winters ever could have. Many of the climate change predictions for the Sierra Nevada are occurring- a trend of higher night time temperatures, higher snowlines and diminishing snowpacks. What was once considered extreme weather may become the norm in the not so distant future. The days of opening Mammoth Mountain on natural snow by Thanksgiving are over. Spring "corn" snow can no longer be counted on as nights become warmer and mid elevation snowpacks melt out earlier. Periods of long winter droughts may become more frequent and persistent weak layers could compete with wind slabs as the main avalanche problem. Snow will probably not be as plentiful as it has been in the eastern Sierra but snow and avalanches always demand respect and provide endless opportunities for learning. ❄

January 5, 2014. ESAC forecaster Sue Burak in a mini-snowpit, 9,300 ft. Coldwater Canyon. *Photo by Preston Few*

KPAC — Winter weather and snowpack: In late March we were still waiting for winter to arrive. This was the sixth driest winter in recorded history with 110 inches (275 cm) of snowfall between November 11, 2013 and March 29, 2014, at 41.5% of mean snowfall at our 10,800 feet survey site.

Snow started falling during the second week of November with an encouraging "opener" between the 21st and 24th dropping 30 inches (75 cm) of snow, and about 3.5 inches of SWE at 10,800 ft. Early storms always elevate hope for a big year; in this case it was short-lived. Early December brought several modest precipitation events, each dropping 5-12 inches (12.5-30 cm) of snow. The total December accumulation was 45 inches (112.5 cm) at 10,800 ft. A renewal of our typical post storm northerly scoring winds of 60+ mph was established as a pattern. Our dreams of winter were threatened and eventually destroyed as the Christmas shopping season brought "The Ridge of Steel," a high pressure of omega block character, which got firmly established over the Southwest for much of the remaining season. January was one of the driest in history with zero precipitation until the last day of the month when a small storm broke the spell. February was not much better and by Valentine's Day the omega block was back for another three bone dry weeks. March picked up a little but nothing too noteworthy. Two storms dropped 12 and 9 inches (30 and 22.5 cm) respectively on the 2nd and 14th.

Throughout the winter backcountry conditions above treeline were wind scoured and eventually bare, except in protected pockets and chutes, where shallow snowpack faceting and wind loading created spatially variable persistent slab conditions. Below treeline the shallow snowpack left terrain obstacles exposed limiting backcountry activity. Side-country terrain, easily accessible from the Arizona Snowbowl Resort, never came into favorable conditions. More remote Inner Basin locations took substantial commitment to access because they required significant hiking. Overall, there wasn't as much backcountry skiing or snowboarding as most typical winters.

A late season (early April) storm provided some redemption for anyone willing to hike into Abineau Canyon. Note soft slap release in the starting zone of Anasazi chute. *Photo by Troy Marino*

Avalanche activity: There were some interesting avalanche problems, but these were spatially variable as a result of inconsistent snow coverage and variable wind loading. On a number of occasions extremely sensitive wind slab overlaying near-surface facet/crust sandwiches produced fracture propagation at low strength. Predictable depth hoar development, given the shallow snowpack, created persistent weak failures on cooler north and northeastern aspects throughout the winter. Several natural and human triggered avalanches were observed. There were no skier or boarder burials reported.

A very late season (April 26) storm provided 45cm of fresh powder high in Abineau Canyon. It took about 5 hours of hiking/skinning to reach this point. *Photo by Troy Marino*

Snowpack summaries: Continuing the tradition initiated last winter, we produced 18 weekly summaries of snowpack conditions between November 29th and March 21st. These were posted in bulletin form on our website by Friday afternoons to benefit increased weekend backcountry traffic. Subscribers were alerted via email link when "Snowpack Summary" went live on the KPAC website.

Backcountry activity: Due to less than ideal backcountry conditions, traffic was limited. We had a 25% decline in the number of winter backcountry permits compared to the previous winter, with a total of 551 permits issued. Still, it was the 7th greatest number of permits issued since the program began in 1998-99, and the second greatest number during a winter receiving less than mean snowfall. These numbers attest to steady growth in winter backcountry interest, though perhaps it reflects a more accurate picture of enthusiasm and anticipation than actual backcountry use. The laser beam counter at the Agassiz Southside backcountry access gate (near the patrol top shack) registered a significant decline from last year as well.

Website activity: We had a modest reduction in website activity this season. Unique visitors to the site were down by approximately 15 % from last winter with a total of 3,198 views between December 1stand March 31st.

Snowpack summaries readership was also down by 20% with 1,122 unique visits. We had a modest increase in the number of subscribers to snowpack summaries via email and smart phone alerts.

Avalanche Education: There were no level 1 avalanche courses offered to the general public this season. Four were scheduled, but due to low enrollment and shallow snow coverage, all of them were cancelled. KPAC did run one level 1 course for Northern Arizona University through NAU Outdoors. Twelve enthusiastic students participated in what was primarily Snowbowl ski area terrain. Despite the contrived conditions, recipients of the training unanimously praised the course's relevance and value. Two free, classroom- based "Introduction to Avalanches" presentations were conducted at the Coconino Sherriff's Department Leaf Auditorium and at the Hart Prairie Lodge at Snowbowl. Each attracted 40-60 participants. As in the past, we participated in the "Science in the Park" event as part of the Flagstaff Festival for Science in September and in the Science, Technology, Engineering and Mathematics (STEM) conference in the Skydome at NAU in April. ❄

—David Lovejoy with contributions from Patrick McGervery and Troy Marino

Mark Staples investigates the crown of a fatal avalanche on Crown Butte that killed an 18-year-old snowmobiler on March 11, 2014. *Photo by E. Knoff*

GALLATIN NATIONAL FOREST AVALANCHE CENTER

GNFAC — Despite plentiful early season snow, five days of extreme cold weather in early December set the stage for much of the avalanche activity during the 13-14 winter in southwest Montana. It was a record year for snowfall (140% of average). The only prolonged dry spell was a two-week period of high pressure in late January. Extreme cold weather in early December and dry weather in late January, formed the only two weak layers. They were easy to find in snowpits but hard to evaluate.

Deep snow made great early season riding conditions and made us optimistic when negative 20 degree F temperatures came in early December. We hoped the snowpack would survive without much faceting but were wrong. A layer of 2-4 mm facets formed about a foot above the ground on most slopes. Plenty of snow fell during the rest of December and early January, and we issued an Avalanche Warning on five separate days. Unfortunately a local snowmobiler died on January 1 during one of those Warnings near Big Sky when he and his partner crossed under an avalanche path and triggered a slide.

After two weeks of dry weather in late January, the main event came. Snow started falling and didn't stop until March 11, 43 days later. The mountains around Cooke City averaged 6 inches of snow per day (18 inches of SWE). During this period we issued another six Avalanche Warnings. The second fatality occurred near Cooke City on March 11, during another Avalanche Warning.

The first weak layer: In December and January, avalanches broke about a foot above the ground on early December facets. This layer fooled me twice. While snowmobiling near Big Sky on December 11, just after the cold weather, my partner and I performed countless stability tests, highmarks, and sidehills (aka slope cuts) with no unstable results. We figured there just wasn't enough of a load or enough of a slab yet. We changed our minds after remote triggering 6 separate avalanches at once. The slab was only 9 inches thick and fist hardness yet propagated the fracture over 900 feet. I was fooled again on January 16 near Bridger Bowl. There had been no recent avalanches, no recent loading, no recent wind loading, and we got stable results in several pits. Just before our descent, my partner cut a cornice that triggered a 3-4 foot deep avalanche. False stables, surprises, and continued avalanche activity on this layer became the norm.

Mark Staples pulls more throttle on a typical field day near Cooke City. *Photo by E. Knoff*

The second weak layer: The second weak layer formed during two weeks of high pressure in late January. As this layer was buried, it became our main concern, but its distribution had no discernable pattern. It existed on some slopes but not others, sometimes on south aspects next to a crust, other times on north aspects without a crust. As with the December facets, surprises and false stable results were common. At some point near the start of March, the January facets suddenly healed and December facets near the ground reactivated. Digging pits to evaluate stability no longer seemed useful. These facets were over six feet deep and existed everywhere. It was just a matter of load and finding the trigger point on a slope.

Tough season: What really stands out is how difficult it was to evaluate the two weak layers.Surprise avalanches and false stable results were normal, and rating the avalanche danger and describing the snowpack was tough. The other thing that stands out is the prolonged avalanche cycles. While there were certainly spikes in avalanche activity, there were long periods when avalanche activity just wouldn't stop even during lulls in loading.

Successful season: As an avalanche center, we continue to grow and receive strong support from the community. We posted 134 advisories that were accessed by over 4,700 people per day. We taught over 90 classes to 4,200 people. We filmed 62 YouTube videos that were viewed almost 100,000 times. We recorded 80 avalanche incidents, a sharp contrast to last season with 27. Unfortunately Montana leads the nation in snowmobile avalanche fatalities, and we work hard to educate this user group. While many challenges remain, we're on the right track. During the last ten years, Montana snowmobile registrations have doubled while fatalities numbers have remained relatively flat. One day this season, I witnessed a group of snowmobilers travelling near Lionhead Peak. As they were crossing a small steep slope, I watched them pause and go one at a time. This task sounds simple, but in practice it is hard to do through an entire day. I later learned that this group had taken our free 1-hour awareness class the previous night and had all purchased beacons, probes, and shovels right after the class. The basics work and we continue to push them in our education efforts.

We couldn't operate without a strong partnership between the Gallatin National Forest, Friends of the Avalanche Center, Montana Fish, Wildlife and Parks, a long list of local businesses, and countless volunteers. On the personnel side, Jay Pape moved to Eastern Washington for a new job with the Forest Service. He remains Treasurer of the Friends but passed along the job of Education Coordinator to Alex Marienthal. Jay started as Education Coordinator in 2006 and made it possible for us to say "YES" to every education request. Since 2006 and because of Jay's hard work, the GNFAC and Friends of the Avalanche Center have taught avalanche safety to almost 35,000 people. Thanks Jay. ❄

—Mark Staples, GNFAC forecaster

Doug Chabot investigates a recent slide on Henderson Mountain near Cooke City. *Photo by B. Fredlund*

FAC — Big Changes and Big Avalanches — *When it rains, it pours*. This summarizes quite succinctly (in more ways than one) the season at the Flathead Avalanche Center (FAC). Sure, the phrase can be taken literally meaning rain on snow events occurred this season resulting a large natural avalanche cycle. Yet, for the mostly new staff at the part-time Type 3 avalanche center, it was a busy season with a continuous deluge of avalanche problems.

The FAC experienced substantial change this season on many fronts. The principal changes occurred within the avalanche center personnel realm. In the summer of 2013 the Flathead National Forest decided to create a director position for the FAC. Hiring processes delayed the implementation of this position and the FNF selected Erich Peitzsch as interim director for the 2013-2014 season. Other changes in personnel for FAC included the appointing of Todd Hannan as a part-time avalanche specialist. Erich and Todd were the regular part-time employees of the FAC. Seth Carbonari assisted with avalanche education courses, accident investigations, unscheduled advisories/updates, and some field data collection. Tony Willits provided some field assistance to aid in the advisories as well.

Flathead National Forest snowmobile staff riders (formerly snowmobile rangers) Lucas Stacy and Guy Zoellner worked as part-time liaisons for the Flathead National Forest and the winter backcountry motorized community. Their duties included education about appropriate motorized recreation zones, avalanche education, and collecting data for the FAC. Overall, it was a strong team effort that produced the public products issued by the FAC.

This season's current funding and resources for FAC allowed for three regularly scheduled advisories per week (Wednesday, Saturday, and Sunday). However, extra updates, advisories, and avalanche classes were deemed necessary this season. Avalanche information product season totals:

Pre-season avalanche information updates (beginning on 11/9/2014) = 5
Scheduled avalanche advisories (through April 5) = 52
Extra avalanche information updates/bulletins/special advisories = 22
# of students reached by avalanche classes affiliated with FAC = 799

Another major change was a retooling of the advisory. Use of established avalanche problems, videos, and photographs helped to communicate the avalanche hazard. Feedback on the new format and overall changes were very positive. The FAC also hosted on their website a 2x/week advisory produced by Kootenai National Forest (KNF) personnel for the Cabinet and Purcell mountain ranges within the KNF.

Timeline

November — Winter came in like a lion in early November with two major storms that provided hope for a bountiful and stable season. Avalanche information updates began on 11/9/2013 with general early season avalanche condition information.

December — Early season promise continued through December with a consistent pattern of storms through the month and the first intrusion of arctic air the first week. These cold temps fostered weak layer development and along with strong winds provided the cause of the season's first reported avalanche incidents. Two incidents occurred in the Swan Range less than a mile from each other and a week apart. Three partial burials between the two incidents caused a few minor injuries.

January — The first week in January saw a storm that began cold and gradually became warmer with rain to about 5,500 feet and our first HIGH avalanche danger rating of the season. The rest of January saw the region under mostly high pressure which was a welcome sight for us sun-depraved northwest Montanans. Unfortunately, this set the stage for the formation of a very persistent weak layer

This is the debris from a D4 avalanche in early March that deposited debris ~3000 ft. downslope in the Middle Fork of the Flathead River temporarily damming the river. This slide began as a dry slab and entrained wet heavy snow on the way down. *Photo Courtesy of the FAC*

Another remnant of the early March natural cycle in the North Fork of the Flathead River. *Photo Courtesy of the FAC*

by creating a melt-freeze crust on sun exposed slopes. This also caused glide cracks to form on sun exposed slopes and at least one of these failed naturally (D3) in the Lewis Range in southern Glacier Park in late January.

February — This is when the show really started. Small storms gradually plunked down new snow on top of this crust, and a prolonged arctic outbreak during the first two weeks of February caused faceting above this crust. Shortly thereafter, continued snowfall in mid-February tipped the scales and we began seeing human triggered avalanches failing on this crust/facet layer. The persistent slab was finally becoming cranky. An incident in the popular Canyon Creek in the Whitefish Range began the spate of accidents with four partial (nearly full) burials in once incident. Another three incidents were reported with a total of three partial burials and 13 people involved in all incidents. Snowfall continued and a natural cycle began with the persistent slab rearing its ugly head. Sadly, this persistent slab was the cause of an accident on February 22, 2014, that involved two individuals and resulted in one fatality in nearby Idaho Panhandle National Forest within Montana. KNF personnel investigated the scene of the snowmobile-triggered soft slab classified as a class 3 on the destructive scale.

Another close call occurred in late February when a suspected natural avalanche failed in Canyon Creek in the Whitefish Range on the same facet/crust combination, and buried one snowboarder up to his neck. This avalanche was perplexing as natural activity had abated for about 10 days prior, and no new load was added in the days leading up to this event. In fact, it was a sunny day where temps rose from about -5°F to right around freezing by the afternoon. Other natural activity was reported in the advisory area this day as well. It was an active month with numerous folks getting surprised by the lurking dragon.

March — This respite was short lived as the largest avalanche cycle of the winter occurred in early March. The seemingly dyslexic storm started with snow and ended with hellish rain to nearly 7000 feet. We issued an avalanche warning for four days in a row with natural activity reported all four days. The apex of the activity occurred on the third night/fourth morning when large (D 3.5-4) avalanches occurred along Highway 2 in the southern portion of Glacier National Park. One slide reached the road grade and another ran under a bridge and continued another 1500 feet finally damming the Middle Fork of the Flathead River for a short period. Assessing the aftermath the next field day was jaw-dropping as widespread D 3.5-4 slides ripped apart forests and deposited debris up to 20 feet deep. SWE totals from the storm ranged from 3.5 - 6.5 inches in five days. The recreating public remained unscathed through this cycle as most folks were smartly unwilling to even venture into the backcountry.

April — We issued our last advisory on April 5. An above average year (~120% of normal) provided plenty of snow to ride and slide on for a while, but spring had sprung for the most part. The typical spring glide avalanche cycle began in late April peppered with a few natural wet slabs during a warmup at the beginning of May. Fickle spring weather continued into May with periodic storms and sunshine interludes; classic spring weather in northwest Montana.

Overall, it was a great and eventful season punctuated on both ends with support from FAC partners. The wildly successful Northern Rockies Avalanche Safety Workshop (held annually in the fall) contributed funds toward a new remote weather station to be located atop Big Mountain at the Whitefish Mountain Resort. The end of the season arrived with the formation of the new non-profit Friends of the Flathead Avalanche Center (FOFAC) dedicated to supporting avalanche education and the FAC. Look for more to come from this motivated group of folks. Other educational partners included the Flathead Snowmobile Association, Big Mountain Ski Patrol, Inc., and the Kootenai National Forest. We also appreciate the support and continual data flow from the Burlington Northern Avalanche Safety Department and member of the public who sent us observations throughout the season. These observations are a tremendous asset. FAC is looking forward to expanding these and other partnerships and subsequent avalanche education efforts next year as well as continuing working towards the FNF's goal of FAC becoming a Type 2 avalanche center. ❄

—Erich Peitzsch, interim director, FAC

VALDEZ AVALANCHE CENTER

Townsfolk were awakened in the middle of the night January 23-24 to what sounded like thunder -it was the thunder of many avalanches descending from the hillsides above. When clouds cleared, one could see plethoras of slab avalanches in every direction. Below 2000', several mountainsides were bare - the avalanches had stripped all the rain-saturated snow off the steeps. *Photo by Sarah Carter*

This photo was shared by the party who triggered this avalanche south of Thompson Pass, March 25. (Notice the tracks they got away with on the adjacent slope?) The weak layer was surface hoar buried almost three weeks prior. Luckily, no one was hurt. *Photo by Alex Graves*

SAWTOOTH AVALANCHE CENTER

SAC — The 2013-2014 season was marked by the arrival of Eric Lutz as part of our forecasting team, terrible early season snow conditions, and sustained snowfall in February leading to an impressive and extremely dangerous avalanche cycle. The year could not have been more different than the last.

Simon Trautman returned for his second year as Director, Scott Savage took over as lead forecaster, and Eric made the jump from crunching numbers at Dartmouth College to riding snowmachines and digging snowpits in the mountains of Southern Idaho. After the government shutdown and a website redesign project that seemed to have no end, weeks of high pressure in November and December actually came as a blessing (que horror!). The extra time without a backcountry avalanche problem (i.e. without snow) allowed us to train in our new jobs, trouble-shoot the website, install and establish communications with our weather stations, and re-design our avalanche awareness and basics classes.

On 11-12 January we issued the first avalanche warning of the season as 1 – 2′ new snow accumulated on a weaker than average snowpack. There were several close calls and skier and snowmobile-triggered avalanches in the Sawtooths, White Clouds, Smoky, and Soldier Mountains.

In February, over a span of three weeks, a series of back-to-back storms delivered one third of the season's snowpack in the central / western Smokys (10.5" SWE at Vienna Mine) and two thirds of the season's snowpack in the southern zones (4" SWE at Soldier R. S.). The event drove an impressive avalanche cycle and culminated in tricky and very dangerous deep slab conditions, five avalanche warnings, and 10 days of HIGH avalanche danger.

On February 13 a snowboarder was caught, carried, stopped by a tree and partially buried in the Bald Mountain sidecountry. The accident resulted in serious injury and an involved rescue. On February 16, a party of four snowmobilers was caught and buried in a large avalanche that released above them in the Frenchman drainage (near Smiley Creek). Although (miraculously) three members of the party survived, one rider was killed (Please refer to http://www.sawtoothavalanche.com/accidents.php for details).

If creek banks can do this….? Simon Trautman checking out scary stratigraphy an hour before a large avalanche buried four snowmobilers less than a mile away. *Photo by Simon Trautman*

Avalanches in burned areas: The Beaver Creek Fire of 2013 burned 115,000 acres within the Sawtooth National Forest. We were lucky to be able to visit several burned areas throughout the season and to ski and snowmobile previously timbered slopes, see new and unique snow distribution and ablation patterns, avalanche debris piles full of soot and spiky black punji sticks, and debris flows forming after wet slides gouged into burned substrate.

Season Highlights:

- We issued our first snow and avalanche announcement on November 19. Daily Advisories began on December 26 and continued through April 13. In total, we produced 118 mountain weather and avalanche advisories this winter.
- The Sawtooth and Smoky Mountains received significant snowfall 19 of 28 days in February.
- Eric purchased no less than three pairs of new skis!
- Scott has not purchased a pair of skis in 15 years!
- We issued 8 avalanche warnings and had 14 days with HIGH avalanche danger… 5 and 10 (respectively) were issued in February.
- We used skis 60% of the time, snowmobiles 30%, and hiked or used binoculars from the highway 10%.
- We spent 120 days in the field and local professional groups contributed ~200 observations.
- Staff gave over 30 interviews to local, regional, and national news organizations.
- Volunteers worked over 400 hours on Avalanche Center operations and fundraising events.
- We redesigned our homepage, advisory format, and weather products.
- Web site traffic increased 20% compared to last year.
- Our advisory received over 160,000 views via the web, email subscription, and recorded hotline. Advisories were accessed an average of 1336 times each day – a 4% jump over last season.
- Public outreach continues to be very successful through the local newspaper, morning radio spots, and social media. Our "Likes" on Facebook increased from 1268 to 1529, with over 50,000 reads this season.
- Avalanche Center staff gave 27 educational presentations (evenly split between recreational and professional audiences). All told we presented to over 1000 individuals this season.
- The US Forest Service increased its annual funding by 10%.
- The Friends of the Avalanche Center provided funding for 2 of 3 staff positions, discretionary spending, and two new snowmachines. Thanks Friends, we couldn't do it without you!!!

What we learned:

- A mid-season snowpack of 25% (30-year average) can turn into a snowpack of 125% in two weeks.
- When this happens, deep slabs may act like persistent slabs … i.e. they are not hard to trigger.
- We need to learn more about deep slabs.
- We need to do a better job of explaining remotely triggered avalanches … it is not enough to mention remote triggers, or to advise against entering historical run-outs …
- We ended up focusing on the travel advice section of the North American Avalanche Danger Scale (during periods of high consequence deep slab problems) instead of the likelihood and distribution. I.e. We had several days where the likelihood and distribution were more indicative of a CONSIDERABLE danger, but the consequential and unpredictable nature of avalanche activity better fit a danger rating of HIGH.

A Big Thanks to Dr. Lutz This summer Eric found out that he has some chronic health issues. To make matters worse, he also found out that the prescription given for rest and recovery couldn't be more different than the working conditions and schedule required of an Avalanche Specialist. In light of this reality, Eric made the very hard choice to resign his position with the Sawtooth Center and focus on his health and his family. We are going to miss him greatly, we wish him well, and we hope to see the Lutz clan show up on an unannounced ski trip to the Wood River Valley. ⁂

—Simon Trautman, former director, SNFAC

While other avalanche centers ride cool snowmachines and ski with the latest gear, WAC Deputy Detective Julian Pridmore-Brown volunteers piloting time and aircraft, on the hunt for avalanches such as this one on Dollar Ridge in the Wallowa Mountains of Northeast Oregon. *Photo Courtesy of WAC*

WALLOWA AVALANCHE CENTER

WAC — Winter in eastern Oregon started out a little slow and light, making for a rather leisurely season for us through most of January. That changed quickly mid winter, with a number of potent wet storms that greatly complicated the snowpack. During the first part of the season, we expanded our advisory board to include expertise in information management as well as youth education. A website overhaul project was well underway in January and we expect to roll out a revamped website this summer.

Our safety education program reached out to the regional community during the early part of the season. Joining snowmobile groups at their regular meetings proved very successful, especially when food was involved! Last spring we awarded a contract for developing a youth education program that we received on schedule mid winter. Our board and newly appointed education advisor provided direction in developing this innovative program that will join our offerings next season.

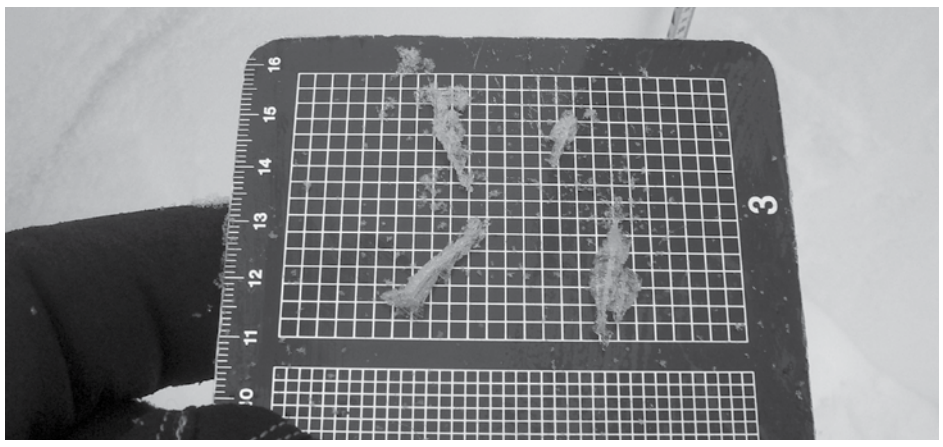
As a non-agency, volunteer center, we strive to adhere to national standards within the limitations our structure allows. Our close relationship with the Forest on which we operate was expanded through initiation of a formal MOU that should be signed shortly. Looking forward to eventual agency support, we worked hard to include multiple districts, hopefully facilitating a cost sharing relationship in the future.

After a long dry spell in January, February brought a number of wet storms that resulted in an active cycle of natural and human triggered avalanches. In the second week of February, one of these events resulted in a single group suffering two fatalities and two injuries in the southern Wallowa Mountains. We quickly found ourselves thrust into coordinating support for SAR, organizing an accident investigation team and answering calls from all reaches of the globe. This accident marked the first such event for us and required a tremendous amount of effort from our small operation. Thanks to the guidance we received from other centers and especially the CAIC, we leveraged our resources effectively though public information statements and a professionally conducted investigation.

March brought improved stability however we kept a healthy respect for the lurking buried weak layers. Another active avalanche cycle was documented by air on March 11. An unusual warming event mid-March had us thinking how the underlying weak layers may react. Luck was on our side, however, as our field observations and subsequent flights showed no major events after the warm up.

We wrapped up our 5th season with an online survey asking our users for feedback on our products. We found our readers want the standard danger scale (no surprise!) and they really like some of the expanded in depth analysis we tried out this year through the "snow-tech" blog. Speaking of blogs, our users really like our bi-monthly non-technical blog just discussing what's going on within our organization. Our public donations were up significantly this season beginning in January and we really appreciate all the support from not only our users, but also the professional avalanche community in general. ❄

—Julian Pridmore-Brown, WAC Deputy Director



Surface hoar from a cold spell in January lingered through February, causing many avalanches and one fatality in the Cabinet Mountains. *Photo Courtesy of IPAC*

IDAHO PANHANDLE AVALANCHE CENTER

IPAC — Winter was expected to be neutral with forecasts for a mild El Nino pattern influencing the Pacific Northwest. Temperatures were on the negative side beginning early which created for a very weak base layer to start the winter. Weak layers developed in the snowpack but the lack of new snow kept IPAC in ready mode, waiting for the next big snowfall to come. The first test came in mid-January with high westerly winds and just enough snow to create a 1 to 2 foot slab. Not a lot of slides were reported during this cycle so the anxiety mounted as we watched the depth hoar get loaded up. January left us with several persistent weak layers of surface hoar. Cold weather and light snowfall allowed it to persist for many weeks afterward. Our advisories all through February included updates on the state of this weak layer since it was buried three feet deep and the crystals were still perfectly intact. This layer was blamed for natural avalanches and accidents all over the northwest and in Canada. An accident in the Cabinet Mountains occurred on February 18 when a snowbiker triggered an avalanche and was caught, buried and evacuated out with broken ribs. Then on February 22, the first known avalanche fatality in the Cabinet Mountains happened involving a snowmobiler on Spar Peak and was recorded by the Flathead avalanche center. Heavy precipitation in March ensued and some of the avalanche problems abated but new concerns arose with warming temperatures and rain, then new snow over dense ice crusts. March precipitation was consistent, 164% of average for the Panhandle and 176% of average for the Clearwater.

On November 9 IPAC hosted a booth with Larry Banks of the newly formed PanhandleBackcountry.com at the Snowlander Snowshow in Spokane, a big event with the ski industry. In early January the Friends of IPAC hosted another successful fundraiser for the Avalanche Center. Raffle items donated by local vendors were auctioned off and in all about $2,500 dollars were raised. The Friends funded some improvements to the website which received about 18,000 hits this year, 6,000 up from last. IPAC Friends worked with an online graphic design app, and someone from Romania helped us design our new logo. Friends President Scott Rulander also conducted an avalanche class for the volunteers helping with the wolverine tracking effort in North Idaho.

IPAC continued to outreach to local high schools educating 170 kids with the Know Before You Go program. Our goal is to reach all the high schools in our three-county forecast region and we may reach that goal next year. I noticed this year that teenagers are wired for avalanche beacons from all that time on their smart phones - Opportunity! Eric Morgan introduced a novel idea of making videos of our pit tests in the field and submitting the movie files to the Sandpoint High School to be viewed at common hour in the morning. This is a great idea since it is easy for us and kids can be exposed to short but interesting clips of avalanche safety topics. I hope we can expand on this next year. This is the first year we conducted an avalanche awareness class for Gonzaga University's Outdoor Program. We continued our partnership with the National Weather Service in Spokane but did not issue an avalanche warning on the NOAA website this year. IPAC worked closely with Schweitzer patrol to stay current on developing weather. This year we conclude our workshops with one last class for the Spokane Mountaineers Mountain School. IPAC conducts a field session in the Steven's Lake basin south of Mullan, Idaho. Avalanche dynamics are geared toward mountaineering and the following day the group makes the decision to attempt to summit 6,838 foot Steven's Peak. This was our fourth season in a row helping with the Mountain School program.

We lost a huge part of our program this year when Carole Johnson was reassigned duties over on the Superior Ranger District in Montana. Carole provided pit data for the West Central Montana AC and Idaho Panhandle AC. Carole started with the program in the 1980s forecasting from the St. Regis Basin and educating people in both Montana and Idaho. Over the years she has taught avalanche safety to thousands of people. I am extremely grateful for having had the chance to work with Carole and IPAC will miss her professional input and observations.

On Schweitzer Mountain, where Doug skied on opening day in 1963, IPAC gathered with friends and family to introduce the Doug Abromeit Avalanche Scholarship. Doug grew up in Sandpoint and much of his family still lives here. IPAC wishes to continue his legacy of his love of the mountains and promotion of avalanche safety and education. In March, 15-year-old Peik Lund was awarded the first scholarship. Peik will attend a level 1 avalanche course next winter. IPAC hopes to continue the Abromeit Avalanche Scholarship with submissions and awards early next winter so the recipients can attend the avalanche class that same year. Thanks to the Friends of IPAC for making the Abromeit Scholarship possible. ❄

—Kevin Davis, IPAC Director

March 10, 2014. Cornice collapse triggers test slope wind slab avalanche on Wildflower Ridge, Mt. Judah, CA. *Photo by Andy Anderson*

TAHOE NATIONAL FOREST–SIERRA AVALANCHE CENTER

SAC — Drought: Fall started out with promise, both for early season snowfall and for avalanches. Snowfall events on October 28, November 20, and December 3 gave us a faceted base that allowed for mellow touring, but left us with concerns for future weak layers. The first avalanche cycle started on Dec 7 with storm and wind slabs failing on those basal facets.

Then things came to a halt and the drought took over in earnest. The snowpack metamorphosed to a very well-developed layer of near-surface facets on top of the basal facets. Significant weak layers lingered in place as dry weather persisted for almost two months until the next storm. During this time, Extended Column Tests (ECTs), Propagation Saw Tests (PSTs), and their two-meter-wide research project versions readily propagated across the full column. With much anticipation a strong Pacific storm arrived Jan 28-31. Rain gauges recorded four inches of rain and snow level rose to an elevation of 10,500′ (most of terrain within the forecast area is between 6,000′ and 10,000′). Snow level eventually dropped, depositing 15 inches of new snow at the tail end of the storm. Most groaned at the missed snowfall potential, but a savvy few rejoiced at the fact that an entire snowpack worth of facets and depth hoar had been destroyed.

Most groaned at the missed snowfall potential, but a savvy few rejoiced at the fact that an entire snowpack worth of facets and depth hoar had been destroyed.

Additional snowfall events were limited in number. The most notable storm cycles during the rest of the season occurred February 6-11, February 27-March 7, and March 26-April 5. During this time a total of five individuals were caught in three different backcountry avalanche incidents that were reported to the avalanche center. These incidents resulted in two partial burials and one full burial. No injuries were reported. Despite the severe drought conditions, 29 avalanches were reported to the center. Countless others went unreported. More info can be found online at: www.sierraavalanchecenter.org.

On April 1 the snowpack measured just 30% of average for the date. Total snowfall amounts for the season were less than 200 inches.

Fundraising and TNF — SAC partnership success

The winter of 2013-2014 once again exhibited the fundraising and management strengths of the not-for-profit Sierra Avalanche Center (SAC) in partnership with the Tahoe National Forest. The proven business plan between these two organizations goes beyond typical Friends Group support with the SAC Board of Directors providing up to 50 percent of the avalanche center's total operating costs each season. This ever-evolving relationship, executed through an annual operating plan and collection agreement, allows the SAC to collaborate with the Forest Service to provide continued avalanche center operations while also collectively focusing on future development.

Working in partnership, the Tahoe National Forest Forecasters and SAC board of Directors developed and implemented a field-based snowmobile avalanche awareness program this past winter. These courses were offered to the public free of charge through a grant from the State of California OHV program. Three field-based courses were taught by lead instructors Brandon Schwartz (Forest Service Forecaster) and Travis Feist (Pro Field Observer) and assistant instructors Duncan Lee (Pro Snowmobile Rider) and Justin Broglio (Former SAC Board President). A total of 22 students were educated in a small group, hands on setting.

This past year, the non-profit partner Sierra Avalanche Center Board of Directors contributed 34% of the funding for the Forest Service avalanche forecasting program. The Board of Directors employed a paid Program Manager position to help raise funds and manage fundraising efforts.

The Board of Directors continued to fund two field observer positions. Steve Reynaud and Travis Feist continued their positions as observers paid by the Board of Directors. The observations provided by Steve and Travis remain an invaluable asset to the avalanche center. Their data, analysis, and willingness to dig deep into the snowpack help make the avalanche forecasts more accurate across the entire forecast area.

On the Forest Service side of things Andy Anderson and Brandon Schwartz continued in their rolls as permanent position avalanche forecasters with the Tahoe National Forest. The continued support for these positions highlights the Forest's commitment to the program and its long term importance. Monies from the Lake Tahoe Basin Management Unit ($23,000), Region 5 ($17,000), and Region 4 ($6,650) echoed this message of support by providing 66% of funds to operate the program this year.

Over the course of the winter we issued four early season conditions updates and 131 daily avalanche advisories. These products covered the Sierra Nevada Range of California and Nevada from Yuba Pass south through the Lake Tahoe Basin and Carson Pass down to Ebbetts Pass. This spanned areas of the Tahoe National Forest, Humbolt-Toiyabe National Forest, Lake Tahoe Basin Management Unit, El Dorado National Forest, and Stanislaus National Forest.

Due to the drought, this season website traffic decreased in page views by 36% and unique visitors by 39% over the previous year. A total of about 299,454 page views from 48,587 unique visitors were recorded this season.

A new website was launched last April and it was very well received and enjoyed by the public this past winter. Both public and professional users continue to send positive feedback and compliment the accuracy, reliability, usefulness, and timeliness of the forecasts and other information provided by the avalanche center. ❄

—Brandon Schwartz, SAC Director

Buried snowmobiler rescue in progress. Prepared companions, an airbag, and a small slope made for a quick live recovery. *Photo by Sarah Whipple*

PAYETTE AVALANCHE CENTER

PAC — For a winter that we never thought was going to happen, the second half was one for the books. We had an early season storm that looked promising followed by two months of high pressure and below average temperatures resulting in what looked to be a very scary snowpack across the West Central Mountains. Despite several notable avalanche cycles, several close calls and two burials, conditions were nowhere as bad as they could have been given the foundation of our snowpack this year.

We issued our first Backcountry Update on December 14 with an average snowpack depth of two feet at the 7000 foot level. Our first advisory came on Christmas Day with an early gift of a foot of new snow allowing local ski areas to open just before the holidays with mostly natural snow on the runs.

Several small storms through the first week of January added depth without improving the structure or strength of the faceted snowpack. During the period of January 7 to January 13 local Snotel sites picked up most of the precipitation for the month in a one-week period. The next two weeks did little to improve the snowpack but gave us our first close calls of the season involving two unrelated partial burials of snowmobilers and a widespread R2+ natural avalanche cycle that ran on basal facets and a thin solar crust at the beginning of a strong inversion and rapidly rising temperatures. While widespread, all of the slides in this cycle were confined to E and ENE slopes that were just starting to pick up their first solar heat of the year.

By January 28, the second act of the winter was just starting with what turned out to be a month of heavy precipitation (aka: The Fire Hose) characterized by high winds, above average temperatures and several intervals of intense graupel accumulation; all this fell on a layer of very large surface hoar and near surface facets. Brundage Mountain Resort reported 75 inches of snowfall from January 28 through the end of February. Snotels averaged just over 11 inches of SWE through the month. Leeward slopes picked up significant amounts of wind transported snow which helped to alleviate the early season basal problems (squash!). Several shallow soft slab avalanche cycles occurred through the first two weeks of February followed by a round of human triggered slides resulting from 2.5 to 5 inches of SWE in a five-day period ending on February 18. Locally, several large (R3+) slides occurred naturally with several reports of skiers and snowmobiler triggered slides all occurring on wind loaded aspects specifically described in the advisory. This cycle coincided with fatalities just across the Oregon border that killed two backcountry skiers in the Wallowa Mountains and a snowmobiler to the east near Stanley, ID. By February 22 we were seeing crown depths over nine feet on northerly slopes. February 24 brought our second warm-up as temperatures climbed into the mid 40s at 8000 feet for several days in a row.

After this break from winter, we put away the Hawaiian Tropic and pulled out the yellow wax and Dutch Harbor Gear as early March turned out to be almost as wet as February with 2.5 to 4 inches of SWE in a five-day storm cycle featuring high winds with day and night time temperatures hovering between 32 and 34F. This storm cycle resulted in no reported or observed natural avalanches despite low test scores and red flag conditions. Leeward slopes boasted more than 12 feet of snow in many areas. Skiers and sledders experienced several close calls and a seasoned backcountry ski guide was completely buried in a terrain trap in poor light conditions. Queue the rain… After flirting with high temperatures, Central Idaho's mountains had rain over 8000 feet and pushed us into our first period of HIGH hazard. Nearly historic sized slides blocked local roads and highways with large debris piles littered with mature timber. A second round of high elevation rain hit us on March 9. These two rain events saturated the snowpack to a depth of almost three feet which took a full week of below freezing nights to refreeze into two solid and nearly impenetrable crusts. Late March highlights included easy digging (since we couldn't penetrate the crusts without jackhammers), a rare opportunity to ski corn snow conditions, great opportunities to work on an early season farmers tan and easy touring conditions. Skiers picked off some big lines under LOW hazard and snowmobiles could go anywhere.

As we were finishing up our forecast season, Mother Nature gave us one more dose of the Fire Hose with a windy five-day storm that made April Fools out of the folks that put their skis away and had summerized their sleds early with 4 to 5 inches of SWE falling on a slick melt-freeze crust. This combo gave us two days of good skiing followed by almost three inches of SWE in a 48-hour span with an upside down snowpack and temps in the mid to upper 30F range again. Our second HIGH hazard advisory of the season was marked by the burial of a snowmobiler playing on a small protected slope. Luckily, he was wearing and deployed his airbag which was partially visible when the dust cleared; he was recovered quickly by his group. The following day brought an additional 1.8 inches of SWE at temperatures averaging just above 10F making for one of the best ski days of the season with 19" of light density snow reported at Tamarack Resort on its closing day of the season.

Other highlights of the season included: 60 PAC advisories throughout the season with 1 seasonal full time and 1 seasonal part time forecaster. PAC and PAC Friends taught 8 classes and participated in several local snowmobile events and ski area festivals. Launch of a new mobile friendly website courtesy of our Friends group, increased traffic on the website with 39% of the total visits being new users. PAC and FPAC co-hosted our most successful fundraiser to date with the Salmon River Brewery in McCall and the generous support of outdoor equipment companies, local and regional businesses and the local community. PAC utilized 376 hours of Volunteer Travel Companion and teaching time help to achieve forecasting and outreach goals with a limited staff and reduced budget. PAC met and exceeded community and local USFS expectations for work produced on a $29,000 budget. PAC partnered with a graduate student from the Boise State University School of Geosciences to begin field testing of a mini FMCW / low frequency radar designed to identify layers and density changes within the snowpack. In addition to the other highlights of the season, we noted a significant increase in snowmobile use throughout the winter. Informal snowmobile parking lot monitoring showed an increase in out of state traffic including California, Nevada, Oregon and Washington and much more weekday traffic than previous years. This increased use probably resulted from the lack of snow in other areas of the West. The only negative portion of the season involved an almost weekly battle to keep our aging weather stations active and producing usable information. A huge debt is owed to the NWS SLC office / Mesowest and the NRCS Boise office for their help with this battle. ❄

—Dave Bingaman, PAC Director

Nearly historic size wet slides near Yellowpine. *Photo by ID-Valley County Road Dept.*

WCMAC — The Snowpack: Perhaps we should have taken it as an omen for the coming year when one of our two avalanche specialists went down in the early January with a severe shoulder injury. Highlights for an unusual winter for the region and our small Type III avalanche center included:

- An urban avalanche that destroyed property and caused a fatality (Mt. Jumbo urban avalanche),
- rare highway closures due to avalanches or avalanche conditions,
- a fatality in the Flint Creek Range, persistent weak layers and several near misses

We had four distinct avalanche cycles this winter and issued an unprecedented ten avalanche warnings. Like much of the west, there was extended high pressure in January that created widespread weak, faceted snow. After it looked like "it would never snow again"; system after system in February and March made it look like "it would never stop snowing".

Very cold temperatures in December created weak snow near the ground to cause our first cycle. There was a respite from avalanche danger during the January high pressure. Weak layers created by this high pressure were responsible for the next couple of cycles through February. Wet, heavy snow in March was the culprit of a late season cycle.

Sledders, riders and skiers seemed to dial it back a bit during the highest periods of avalanche danger. Considering the periods of unstable snow, there were only a few reports of human-triggered slides; of course we didn't hear about all of them. We were able to interview two people (one sledder and one skier) that were fully buried and recovered successfully with no injuries.

The Center was asked by the Forest Service to investigate an avalanche fatality in the Flint Creek Range that was out of the advisory area (Altoona Lakes Avalanche Accident). Folks from Missoula frequent this range and the Center has investigated slides and fatalities on Forest Service land previously in these mountains. On March 10, a well-known ski coach and Missoula businessman triggered a large slide that ran on mature depth hoar. He was caught and carried the full length of the avalanche and succumbed to injuries sustained during the slide and/or asphyxiation from the burial.

The Flint Creek Range, although a two-hour drive from Missoula, does not have the typical intermountain climate. The 13 western counties in Montana are, geographically, part of the Pacific Northwest. There is a strong maritime influence on the snow. The relatively higher elevation, colder temperatures and a generally shallower snowpack in the Flint Creeks often builds weak, faceted snow associated with continental climates. We felt that unfamiliarity with deep weak layers and the very dangerous nature of these layers were considerations in this accident.

With a record snowpack, the avalanche season continued into May in West Central Montana. On May 3, 2014 a 46-year-old math teacher from Anaconda, Montana, died from injuries after being caught in a wet, loose snow avalanche in the Flint Creek Range. The victim was an experienced backcountry skier and traveling solo. He was either entrained in the wet snow avalanche and could not escape or the slide overtook him and knocked him down. He was carried 760 feet and caught against a group of trees. He was partially buried and able to initiate response with a cell phone. Sadly, he died from internal injuries.

The Flint Creeks received 10-15 inches of snow packed with 1 inch of snow water the last week of April. The new snow was deposited on a firm, frozen surface. 48 hours before the accident, mountain temperatures remained above freezing for the first time this spring.

Avalanche accidents involving wet, surface slides in the late season are less common. This tragedy serves to remind us to be mindful that avalanche hazard persists on steep mountain slopes into the spring and summer.

Education: Awareness classes, lectures and workshops were held for Mineral County Search and Rescue, Missoula County Search and Rescue, snowmobile shops, snowmobile clubs, the general public, local middle and high schools, the University of Montana and Forest Service employees. These programs had 734 participants.

Our "friends" group, Missoulaavalanche, partnered with the University of Montana to offer Level 1 classes for 55 participants.

Media: Missoulaavalanche.org, the Center's "friends" group concentrated on Facebook presence this year. It appears, at this point, more people are accessing the advisories through Facebook than through the missoulaavalanche.org website.

Volunteers working on our Facebook page made it easier to post the advisory and warnings. They created a post called "Share the Snow Luv" for constituents to post backcountry photos, created ads and photos for fund-raising events and created an album highlighting supporters and gear sponsors. Also on Facebook, they initiated posts each week that engaged readers; these included images from backcountry observations and links to educational videos and articles.

Funding: Missoulaavalanche.org is a 501(3) (c) non-profit that supports the West Central Montana Avalanche Center through a cost-share agreement with Lolo National Forest. Although the Forest Service is responsible for the avalanche advisories; the non-profit provides all operating funds, including salaries for the forecasters (avalanche specialists) and educators. Funds are raised primarily through the efforts of the folks on the missoulaavalanche.org Board of Directors. As a testament to those efforts; missoulaavalanche.org was able to purchase a much-needed new Ski-doo snowmobile for the Center this year.

The work involved with the Mt. Jumbo Avalanche, while providing backcountry advisories and avalanche education, stretched the budget quite thin. To that end, missoulavalanche.org created an online petition asking the Forest Service for renewed commitment of the West Central Montana Avalanche Center - http://www.missoulaavalanche.org/2014-support-petition/ . Let's hope their advocacy pays off. ❄

—Dudley Improta, WCMAC Avalanche Specialist

Surface hoar was created during the extended high pressure in January. The photo shows the layer buried in the Feb. 2 snowpack with a close-up and an avalanche class in the background. The pit is in our study plot near the Snowbowl Ski Area (Rattlesnake Mts. near Missoula). *Photo by Dudley Improta*

Craig Gordon not only organized the Utah Snow and Avalanche Workshop but was the MC, wearing his usual tuxedo, no less. Over 700 people attended from throughout the Intermountain region, making it the largest annual avalanche workshop in the U.S. *Photo by Bruce Tremper*

UTAH AVALANCHE CENTER

UAC — It was one of those years when double the annual average snow fell north of us in Wyoming with half the annual average snow in southern Utah. The dividing line ran through Ogden with the Logan area mountains ending up with 120% of average; the Wasatch Range, Uintas and central Utah ended 70-80% of average; southern Utah had 20-40% of average. It was also warmer than average with several rain events and a higher rain-snow line. The mountains looked similar to how Evelyn Lees described a previous year - "It's as if a child had decorated a cake with frosting, but had all but forgotten the sides."

But the details of how, when and the type of the storms is much more important than the total amount. By the end of a fiendishly cold December, total snow hovered around heartbreaking half of average, which meant that Utah harbored a thin, weak, rotting snowpack that could not support much weight once it ever started snowing in earnest. The drought finally broke in February, which was also our snowiest month of the winter. And just as we predicted, the avalanches suddenly roared to life. On February 8, with the arrival of a wet, warm storm with rising rain-snow line, we issued an Avalanche Warning and the advisory stated, "A HIGH avalanche danger will border on EXTREME this weekend. Avalanche runout zones are to be avoided as they may be triggered at a distance and below." Two people died in separate incidents over the next two days. The snowpack remained persistently dangerous through much of February with several days rated as High and Extreme. The Logan area mountains were especially unstable with many large, deep slabs triggered by people and several very close calls. The deep slab instability had mostly settled out and by March except in the perennially shallow, weak snowpack of the Uinta Mountains where large, deep avalanches continued well into March. Unfortunately a snowmobiler was killed on March 7.

Close Calls: We had a near-record human triggered avalanches with many close calls including eight full burials, of which three died, two were near the surface and extracted themselves and three miraculous recoveries in the Logan area mountains, all of which involved snowmobilers who were totally buried in separate incidents and the victims were recovered by their party members, not breathing, but responded to CPR. One victim broke multiple bones and survived only because of heroic rescue efforts in very difficult weather. Rescuers had to haul him to the top of a long slope using ropes. In another incident, the party lacked beacons or shovels but luckily they spotted a couple fingers of the victim's red gloves sticking out of the snow. You can find more information on these and other incidents on our website at UtahAvalancheCenter.org.

Fatalities:

AMERICAN FORK - TIBBLE FORK RESERVOIR, FEBRUARY 8, 2014

A group of snowshoers from BYU was traveling in a gully just two hundred feet off the road, near the Tibble Fork parking lot in American Fork Canyon, Provo area mountains. The group triggered a small avalanche and 21-year-old Ashleigh Cox was caught and swept into the water at the bottom of the creek bed and buried. Approximately 40 minutes later she was recovered, face down, from the water with no pulse, and did not respond to CPR. She died the next day in the hospital. The avalanche was a small soft slab - about 18 inches deep, 230' wide, and only traveled 125' vertical. The steep slope ended in a classic terrain trap gully, and was at the low elevation of 6400'. The avalanche occurred right after the largest storm of the season, when wet heavy snow mixed with rain occurred at the lower elevations, falling on about a foot of faceted snow that was becoming saturated with water. A late January rain crust may have been a player in the avalanche stratigraphy. Gullies seem small and unassuming to those with no avalanche education, and can often look like natural logical paths to travel in the winter.

MANTI SKYLINE - HUNTINGTON RESERVOIR, FEBRUARY 9, 2014

A group of four experienced snowmobilers, all with avalanche rescue gear, were out for the day. Clinton Conover, of Ferron, Utah, circled up a slope to aid his friends with stuck snowmobiles when he triggered the slide that caught, buried and killed him. His friends immediately began rescue efforts, but he was buried six to eight feet deep. It took 20 minutes to extricate him, and he did not respond to CPR. It did not occur in the typical big, open terrain of the Manti Skyline but on a small, wind protected bowl with well spaced conifers. The group specifically avoided large slopes that day because of the avalanche danger. The slab collapsed on faceted snow below a mid-pack rain crust. The rain crust allowed the slab to connect across a fairly wide area, and run out an unusually long distance.

WESTERN UINTAS - GOLD HILL, MARCH 7, 2014

Ryan Noorda and his brother were heading back to their RV, and stopped to play around on a smaller slope. It was complex treed terrain - a short steep slope, but connected to steeper terrain above. The four-foot-deep hard-slab broke 200 feet wide and was most likely triggered from below. The avalanche buried Ryan deeply on a bench where the snow piled up. His brother found him with a beacon search, extricated him and performed CPR, heroically aided by another group. Medical personnel pronounced him dead on the scene. This was a sad accident, where even a relatively small avalanche combined with the bad consequence of a terrain trap proved to be fatal. ❄

—Drew Hardesty, forecaster, UAC

Go to UtahAvalancheCenter.org for a more detailed annual report.

The Logan area mountains experienced one of the largest avalanche cycles in years with a number of large, full-depth avalanches triggered both naturally and by snowmobilers. There were three total burials with miraculous recoveries. This is a very large, deep-slab avalanche on Logan Peak triggered by snowmobilers from the bottom of the slope. The person buried did not have a beacon but luckily had just the tips of his glove fingers visible. *Photo by Toby Weed*

Frank Carus and his master, Lily the Avalanche Rescue Dog, investigate a large and highly unusual avalanche on the summit cone of Mt. Washington. *Photo 1. Joe Klementovich*

MOUNT WASHINGTON AVALANCHE CENTER

MWAC — The Mount Washington Avalanche Center had a good season in 2014. Overall, the snow conditions and avalanche activity were not spectacular, but it was better than many recent seasons. This year was particularly noteworthy due to atypical snowpack conditions and some unusual avalanche activity. Outside of snow and avalanches, it was another busy season for the Snow Rangers. Inbetween snow assessments, search and rescue missions, and shivering through an colder than average winter, we kept the program moving forward by leveraging social media, smart phone apps and live presentations to spread our safety messages. The season kicked off in November with the third annual Eastern Snow and Avalanche Workshop. Attendance was strong again this year, which is prompting us to look closely at how the workshop might grow in the future. One avenue for growth was the development of a monthly continuing education series, which will likely continue in the 2014-2015 season. We also kept our PowerPoint skills sharp, delivering presentations on the state of the art in resuscitation for burial and immersion and best practices for organized avalanche search and rescue to a variety of audiences, as well as the keynote presentation at the Northeast Weather Conference.

As has become common in recent years on Mt. Washington and in the Presidential Range, the late fall months of October and November provided scant snowfall. By early December, the terrain had been barely filled in at all by early snows. This was unfortunate because December was a good month for snowfall, but fell on limited bed surfaces. However, by January 1, it still didn't feel like we had a lot of snow in the ravines. A close look at the data showed that while the snow totals recorded at the Mt. Washington Observatory were 32% above average, snow water equivalents were actually 8% below average. An optimist might look at it this way: average water to snow ratios in December 2013 were 8% compared to the 30-year average of 17%. But in reality this was not enough snow to make up for what hadn't fallen in the early season, and unfortunately January also followed the recent trend for below average snowfall totals.

An early January rain event followed by sustained cold temperatures helped the snowpack develop in a way we don't often see. By mid-January, we were beginning to see persistent problems caused by a buried facet layer. This layer was the culprit in at least two human triggered avalanches, each unintentionally triggered by Snow Rangers doing field assessments (neither was caught or carried.) It also played a role in several naturally triggered avalanche cycles, leaving us doing our best to track the locations of where this problem layer may or may not remain within our micro-scale forecast areas. We discussed this as a problem in the advisory over the course of the rest of the winter. Persistent weak layers are rarely a problem on Mt. Washington for a variety of reasons, most dominantly due to intense bridging, so this year was atypical in this regard.

Facets around a February rain crust contributed to our most interesting avalanche of the season. A snowfield on the Washington summit cone fractured and failed in late March, which was likely triggered by a group of hikers descending through a rocky area at the top of the slope. About 20 hikers and skiers were in the immediate vicinity when it occurred, but fortunately and miraculously none were involved. The crown for this slide measured at a maximum of 1.45m, and debris as much as 5m deep. To our knowledge, this slope had only failed as a delayed action/non-storm event once in the previous 50 years, which was much smaller than this year's event. The slide prompted much discussion among the local community, and caused a lot of skiers and climbers to rethink their assumptions and beliefs about avalanche terrain on Mt. Washington.

The season really began to come together in late February and throughout March. Like December, snow totals for the later winter months were above the historical average. But again, SWE was well below average. Many areas had finally filled in by the end of March, but other locations around the Presidentials had not developed as fully as one might expect if only looking at snow totals. Overall, by the time the annual spring ski season began, the mountain snowpack was ready for the crowds to begin arriving.

In addition to avalanche forecasting, MWAC has the atypical responsibility as the lead agency for search and rescue within their forecasting terrain. Avalanche accidents were minimal this season, but with a few close calls. In one incident in late December, a pair of hikers triggered an avalanche in a Tuckerman slope called "The Lip". In this event, the hikers did not intend to be in avalanche terrain, but got off their intended route and dropped into a slope rated Considerable danger and were avalanched over a series of cliffs. In another case, we believe a small wet slab was triggered by a skier's induced wet sluff in an April accident. Both resulted in significant injuries but no burial. Like most years, we also helped with a wide assortment of other incidents and accidents with skiers, hikers, and climbers.

As with many other avalanche centers, MWAC relies on partnerships to accomplish its mission. We would like to sincerely thank all the groups that help us out. In particular, the Mount Washington Volunteer Ski Patrol continued to impress us with their dedication of helping spring visitors. The Friends of MWAC group stepped up to the plate in their second season, donating approximately $6500 worth of equipment such as smart phones, an airbag pack, high powered headlamps, and a cell signal booster for our backcountry cabin. Additionally, numerous search and rescue organizations assisted with the SAR responsibilities, and Friends of Tuckerman Ravine helped with maintaining trails in our area. Thanks to all the groups who helped us through the season, and thanks to all the snow enthusiasts who help motivate us to do the best work we possibly can. ❄

—Chris Joosen, MWAC Director

MT. SHASTA AVALANCHE CENTER

MSAC — February 11th, 2014 I put my skis on for the first time of the season. Not by choice, but because that was the day when a skier could legitimately slide downhill without a good chance of injuring oneself on stumps, sticks and rocks. The avalanche advisory up until February 11th had morphed into something of a recreation status report. I struggled to keep spirits high with jokes and inspiring quotes such as this one from Lao Tzu, "It is not the answer that enlightens, but the question." Ummm, so… Where is the snow?

Ice skating and pick up hockey games on backcountry lake ice were the soup de jour for many December and January weekends. The local mountain bike trails were in great shape. South facing rock crags were quite pleasant on sunny days. Longtime locals said they hadn't seen a winter as dry as the 2013/14 season since 1976/77, the last season when the Old Ski Bowl Ski Area didn't open. This year, the Mt Shasta Ski Park and neighboring Mt Ashland Ski Area did not open. Freezing levels kept snow above 6,500 feet for most of the winter.

Despite our half winter season, the MSAC continued to operate as normal. While we still produced the same number of advisories as years past, in general the rest of our numbers were reflective of the winter: about half! The MSAC issued a total of 58 advisories and recorded 36,461 website visits, December 1 through April 30. Advisories are disseminated through the website (www.shastaavalanche.org), phone recordings, emails, and are posted at the Mt Shasta Ranger Station and open Mt Shasta Wilderness trailheads. The MSAC continues its education program and strives to expand and enhance the classes and workshops. We taught 11 classes totaling 72 hours. These included our four monthly (December – March) free avalanche awareness classes and companion rescue clinics for backcountry users as well as snowmobile specific avalanche workshops. This year the MSAC received a California OHV grant which allowed for the purchase of two 2014 Polaris PRO RMK snowmobiles and trailer along with the new implementation of four free snowmobile-specific avalanche awareness/companion rescue workshops. Further, the grant provided funding for avalanche forecaster salary, education materials, trailhead signage and website work. We are excited to continue our snowmobile education and outreach in the future.

Other education the MSAC continues to conduct includes collaborative winter trainings and classes/workshops with the Siskiyou County SAR, Southern Oregon University, Southern Oregon Nordic Club, USFS snow survey crews, local school groups, Mt Shasta Ski Park, Crater Lake National Park and special needs groups. The MSAC enlisted a handful of volunteers again this season and their efforts totaled 65 hours. Their roles served as field observers, backcountry travel partners, and education assistants.

The forecast area saw a couple human triggered and natural avalanches in February and March. One of note was a HS-AS-R2-D2 slide that occurred on March 11, capturing and partially burying three experienced skiers on the South side of Mt Shasta, 9,200 feet. This was a wind slab that had formed directly after a weekend of stormy weather, followed by wind and clear visibility above treeline.

The Anaconda slide, one of the most notable slides we had this winter. *Photo by Forrest Coots*

Two other rather lengthy avalanches of note were natural slides that occurred in Avalanche Gulch/Casaval Ridge area on March 2 or 3. The slides started up near the 11,500 to 12,500 foot elevation in Avalanche Gulch and off of Casaval Ridge and ran down below Helen Lake (10,400ft). Nobody was caught. It's not often we see slides run past Helen Lake like this.

The Friends of the MSAC are still going strong with continued support, fundraising and a few new members to the board. The annual SNOW BALL was a big success, along with several movie nights. The second Annual Shasta Ascension Randonee race had to be cancelled due to lack of snow. The Mt Shasta area finished off the wet season (September 1st through April 30th) at 36% of normal. We received 14.17 inches of water and normal is 39.06. We are committing positive thoughts towards a cold, precipitous winter next season and hope you are too!

Nick Meyers continues to serve as the sole employee and Director of the MSAC. He continued his professional development this season by attending the AAA's 8-day AVPro course in Lake Tahoe. His current winter duties include running the avalanche center, teaching avalanche education, as well as Wilderness Climbing Ranger and SAR duties on Mt Shasta. Busy is one way to describe his winter schedule! His time off is best spent not on a windy, cold, rocky mountain and prefers lying on a beach in Baja with his wife and dog Bandit, surfing, sipping cerveza (Spanish for beer), and exploring on his motorcycle.

The Mt Shasta Avalanche Center thanks each and every one of the local community members for continued support. The MSAC would also like to thank the avalanche community at large for everyone's hard work and commitment towards advancing all things snow, weather and avalanche related. It takes a village! ❄

—Nick Meyers, Director, MSAC