36.4
APRIL 2018

# THE AVALANCHE REVIEW

*the photo issue*

## SANDPOINT, IDAHO DDL

**SCHWEITZER MOUNTAIN RESORT:**
Morning mitigation work after two days of snow and wind produced this HS-AE-R3-D4 triggered by a 2kg charge. The bed surface was a PWL comprised of facets overlying a late November rain crust. The crown ranged from 170 to over 300cm.

*Photo by Tracy Tuttle*

# THE AVALANCHE REVIEW

*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.

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AMERICAN AVALANCHE ASSOCIATION


## A3 STATEMENT OF PURPOSE

The American Avalanche Association promotes and supports professionalism and excellence in avalanche safety, education, and research in the United States.




**Subscription:** $35 per year (4 issues). Subscription is included with membership dues to A3. 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 A3 or the organizations with which the authors are affiliated unless otherwise stated.

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## CONTENTS / DEPARTMENTS



## CONTRIBUTORS

**Eric Knoff** is a forecaster for the Gallatin National Forest Avalanche Center in Bozeman, MT. He has always considered himself a skier, but is often surprised how much he enjoys snowmobiling. He's doing his best to avoid an impulse purchase of new Ski-Doo 850. When Eric isn't skiing, sledding, and digging holes in the snow, he owns and operates a fly fish guide company out of Bozeman.

**Russ Costa** is an Associate Professor of Honors & Neuroscience at Westminster College in Salt Lake City, Utah, where he teaches about minds, brains, data, science, decision-making, and many other things. He studies attention and perception inside the lab, and risk and decision-making outside of it—preferably in the mountains.

**Evelyn Lees** Spending 26 seasons as an avalanche forecaster at the Forest Service Utah Avalanche Center has just been a sideshow to my family and the rest of my life outdoors. Good news is that Rick (Wyatt) and I now have two trail breakers and rope guns.

**Mark Staples** Mark Staples is the director of the Forest Service Utah Avalanche Center and is an avid snowmobiler and now snow biker. A reality of the sport, especially in tight trees and narrow gullies, is that you are basically alone for a good percentage of the day. This study has opened his eyes to all the times we are effectively alone while skiing or doing other non-motorized sports.

**Erich Peitzsch** can still be found chasing his two young boys around the mountains wondering where all of his time goes.

**Doug Krause** is a guide/forecaster for Valdez Heli-Ski Guides; the Director of Professional Development for the Silverton Avalanche School; and the on-again, off-again host of *Slide: The Avalanche Podcast*. You'll find him on the South Island this summer selling rocks for blade time.

# FROM THE EDITOR

BY LYNNE WOLFE

**Welcome to the** final issue of the 36th volume of *The Avalanche Review*. In this issue, we will examine this winter's extended example of how weather is the architect of the snowpack. A broad and persistent ridge of high pressure sat over much of the west for much of the crucial snowpack-building month of December, depositing facets and surface hoar over a Thanksgiving rain crust. This weak structure, which we are calling the DDL—December Drought Layer—was then loaded across the North American west from north to south as the high-pressure ridge ebbed and flowed, causing an avalanche cycle that extended from the Kootenays in British Columbia to the Flathead to Missoula, then south to the Tetons, the Wasatch, and parts of Colorado. Apologies if we have missed anyone. In this issue of TAR, photos and forecaster narratives describe the cycles in each of these locations, while CAIC meteorologist Nick Barlow offers some insight to the weather patterns. Pay attention to your spring wet-slab cycles to see if the culprit DDL reawakens as predicted!

The April TAR usually follows a human-factors/decision-making theme, and under that banner, you'll find a mini-theme of stories that address impulse decision-making. Eric Knoff, Russ Costa, Doug Krause, Eric Peitzsch, and Evelyn Lees/Mark Staples of UAC with a connected piece about solo skiing all provide thought-provoking insights and take-home tips on this topic. See which tip sheets you cut out and pop into your wallet.

This winter, TAR seemed to attract an array of fabulous photos; this issue showcases shots from Wasatch photographer and UAC observer Mark White, who seems to share my love for the lines of shooting cracks and crumpling slabs; from Selkirk guide Laura Adams, whose moody images of big stormy peaks inflamed my need to go wander around in the mountains; and, finally, Nick Meyers, who sends another set of striking shots from around his home mountain, Shasta.

This has been a challenging winter for many of us, with shallow, weak snowpacks and tricky avalanche problems to navigate. With a sigh of relief, we watch our snowpacks warm and persistent-slabs fade from problem lists. My problem list this winter didn't include the DDL; I've been navigating the uncertainty of breast cancer. I'm doing well now as spring arrives and I work my way through treatment. The uncertainties and protocols related to this challenge aren't unlike those in avalanche decision-making. I'm having to maintain margin and rely on communication and community. I'm coming out strong due to the support of my amazing community. Thank you to everyone who has brought soup or sent a note; on the work front, special thanks to Charlie Rubin and Karen Russell, who both stepped up to help edit this issue of TAR. I've continued with my TAR work as both it and you are very important to me. With that said, I won't make it to ISSW 2018 in Innsbruck this fall. I hope that those of you who attend will take note of outstanding and relevant presentations and conversations. Keep TAR in mind for those, please. ▲

*Photo Dan Powers*

## Entertaining email banter among avalanche workers:

**Don Bachman:**
Here's some current risk(y) research being done here at MSU:
www.montana.edu/news/17430/msu-researchers-seek-answers-to-what-drives-risk-taking-in-avalanche-terrain
(Jordy Hendrickx and Jerry Johnson's White Heat project)

**Ron Perla:**
Thanks Don,
Why risk?
Maybe snow is so soft, inviting and pure,so how could it be so deadly?

As they would say about the oldest profession: a night with Venus, and a lifetime on mercury.

**Lynne Wolfe:**
Perla you do have a way with words. You might just get quoted in the April TAR.
Thanks Don for the link.
All is well here.
Judson—report in, please.

**Art Judson:**
Thanks D.B. Reporting in as asked. All well here. Over...

**Don Bachman:**
Ah, the risk; I'd have to say that gravity is not just a good ideal—it's the law.

**Dale Atkins:**
Hmm… wonder if Robin—after reading both adages—would have exclaimed, "Holy homophones, Batman—
Sisyphus and syphilis!"

OK, I know, the words are not quite true homophones, but I never thought I'd ever have the occasion to use all three in the same sentence.

## 36.3 Correction

Ooops. Scott Toepfer was misidentified as Doug Richmond in the CSAW summary.

Anstey Mountain 2360m. Northern Monashee Range, British Columbia, Canada. January 2018. *Photo Laura Adams*

# FROM THE EXECUTIVE DIRECTOR

BY JAIME MUSNICKI

**We'd like to** welcome the three new A3 trustees who were elected during the special election this winter: Jake Hutchinson as Membership Trustee, Erich Peitzsch as Governance Trustee, and Sean Zimmerman-Wall as At-Large Pro Trustee. These three individuals, along with the other elected A3 Trustees (President, Vice President, Secretary, and Affiliate Trustee) will serve terms through the end of 2018 and, should they choose, be up for re-election during the regular A3 Board election period this fall (two-year terms elected in even-numbered years). Here's a little more about each of the new Trustees…

JAKE HUTCHINSON, Membership Trustee, has served previously on the A3 Board as the Certified Instructor Representative and sits on the A3 Education Committee. Jake lives in Park City, UT, and currently works as an educator for American Avalanche Institute in Wyoming, Utah, and Colorado and as a forecaster for Glacier National Park's Going to the Sun Road in the spring. His avalanche experience also includes work as a ski patroller in UT and as a dog handler. He "feels strongly that without our members [A3 is] nothing and [is] actively seeking ways that A3 can better represent and support our membership." In his new role as Membership Trustee Jake will strive to "connect with a large part of the A3 membership through [his] instruction in multiple regions and across a variety of professional sectors."

ERICH PEITZSCH, Governance Trustee, has also served previously on the A3 Board as the Intermountain North Rep and has been closely involved with the changes to the A3 Board structure over the last couple years. Erich lives in Columbia Falls, MT, where he is a physical scientist and forecaster for Glacier National Park and an educator on local avalanche courses in the Flathead Valley. In case that wasn't enough, he is also currently pursuing his PhD at Montana State University. Erich "bring[s] a broad perspective as a researcher, forecaster, instructor, and former patroller to help represent the membership and help lead the governance committee through attention to detail and organization," and is excited to continue working with A3 as it continues "progressing through a period of exciting, positive change."

SEAN ZIMMERMAN-WALL, At-Large Pro Trustee, is new to the A3 Board in this role, though he has participated in the Education Committee for a number of years. Sean lives in Sandy, UT. He ski patrols, guides, and teaches avalanche courses in Utah and Patagonia. Sean "see[s] the American Avalanche Association as a vehicle for advancement in education and advocacy within [the avalanche] industry," and is excited to encourage "the Board to work more closely with professionals in an effort to tap the vast resources and capture the wealth of knowledge that exists within our community." ▲


As a small token of thanks for their service on the A3 Governing Board, outgoing trustees will receive custom steel plaques by Colorado metal artist Lisa Issenberg of Kiitellä (Finnish, meaning "to thank, praise, applaud).

**The process:** One of Alaska photographer and Chugach avalanche forecaster Heather Thamm's mountain scenes was sublimated onto aluminum, framed by and riveted to thick plate dark steel, polished in Kiitellä's signature style, and completed with a stainless steel jetcut A3 logo and hand-stamped pewter recognition plate with each trustee's name. Kiitellä's process includes a mix of both handcraft and industrial techniques. No two plaques are exactly the same. To see more work by Kiitellä, visit www.kiitella.com.

## THE ED MOVES ON

After four and a half years in the Executive Director role for A3, JAIME MUSNICKI will be moving on from her position later this spring to put her energy in new and different directions. The A3 Board is currently engaged in the search and hiring process for a new ED. If you or anyone you know may be interested in and well-suited for this role, you can find more information on the A3 website (www.americanavalancheassociation.org/employmentlist/).

Email employment@avalanche.org or contact any A3 trustee with questions.

# PRO AVSAR GUIDELINES UPDATE

INTERVIEWS CONDUCTED BY SEAN ZIMMERMAN-WALL

**In the United States**, there are numerous mountain professionals who are committed to maintaining a high operational standard for those engaging in Avalanche Search and Rescue (AvSAR). The A3 Education Committee wishes to share the latest developments as the guidelines near completion and we work toward a formal launch. The following interviews were conducted to gather a perspective of the process thus far, challenges encountered, and thoughts on implementation moving forward. I started with two instrumental players in the guideline development, Nick Armitage and Maura Longden, then gathered input from longtime practitioners/instructors Jake Hutchinson, Jim Donovan, Steve Achelis, and Eric Murakami.

Nick Armitage and Maura Longden

*1. What is your professional background?*

**Nick**—I have worked as a ski patroller and forecaster at Big Sky, Montana, for 10 years and as an instructor for the AAI for three winters. I am currently working as a climbing ranger in Grand Teton National Park.

**Maura**—I am a search and rescue instructor and the owner of High Peaks Rescue Training. Nick and I cochair A3s Search and Rescue Committee. My background includes over 35 years as an NPS climbing and search and rescue ranger, wilderness manager, avalanche forecaster, educator and ski patroller, mountain guide, and search dog handler.

*2. Describe your involvement with the drafting of the guidelines for AvSAR. (collective responses)*

The Pro AvSAR curriculum development started in the fall of 2014 when conversations with Kirk Bachman about the rescue fundamentals class naturally led to the issue of "what's next?" Since then, there have been so many great contributors and advisors on the project, it has taken on many shapes and sizes.

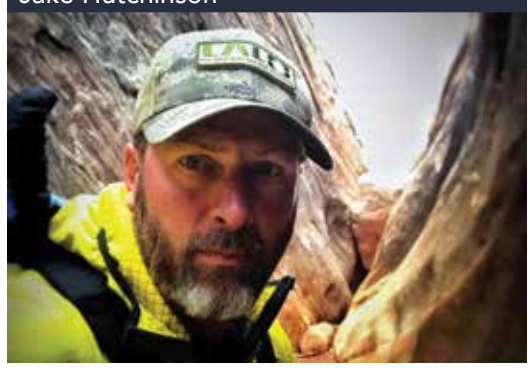
*3. How have you engaged the pro community in the development of the guidelines, and when will they be finalized?*

I (Nick) have tried to stay more in the "engine room" of the course development and leave the community engagement to the A3 staff and Education Committee. Maura and I have tried to address comments and concerns directly to those who have taken the time to look over the guidelines. Maura is currently working with ICAR standards for more continuity with the international community. The next round of comments and edits will be complete by April, allowing providers time for implementation.

*4. What challenges do you foresee with the implementation of the guidelines, and who will be eligible to teach the courses?*

The greatest challenge is continuing to improve the guidelines based on the experience of instructors and students participants. Although providers should use the guidelines, they are encouraged to teach courses suited for different SAR groups. Currently, the guidelines state that the courses will be staffed by at least one A3 approved Lead Trainer and the other instructors must meet the requirements for A3 Professional Trainers. www.americanavalancheassociation.org/educators

Jake Hutchinson



*1. What is your professional background?*

I have more than 21 years as a pro patroller at Canyons in Park City where I spent time as lead avalanche forecaster and patrol director. I was vice president of Wasatch Backcountry Rescue for over a decade, spent three years forecasting for Going To The Sun Road in Glacier National Park, and was a Level A dog handler for many years. I was involved in numerous multi-agency avalanche rescue/recovery operations throughout my career and a professional avalanche educator primarily for AAI for nearly 20 years.

*2. How do you see AvSAR fitting into the Pro/Rec split?*

I think it both fits and stands alone. Many people involved on the SAR side aren't avalanche practitioners but have very thorough backgrounds in ICS and other search disciplines. AvSAR gives students subject-matter expertise and the ability to interface with teams that are more familiar with avalanche hazard and forecasting. For the avalanche community, this is a step into the far more universal ICS system, which promotes seamless integration among different agencies with unified command structures and more accountability.

*3. Describe the type(s) of courses you are currently offering that meet similar criteria and how they will be adapted once the guidelines are accepted.*

Dave Weber and I developed one of the first multi-day Pro Avalanche Courses in the US a number of years ago. It goes into depth on some technical rescue topics not covered by the AvSAR guidelines but was the basis for most of my recommendations to the AvSAR program. I don't anticipate our course changing much. We have had a few students successfully apply for a PLA with the CAA, and we have tried to anticipate the course outcomes as much as possible to allow our former students a PLA option in the future.

*4. Who are the most reliable consumers of this kind of instruction, and how do you meet their needs currently?*

Ski Patrol leaders of all levels, SAR, EMS, and Law Enforcement have all successfully completed our course and felt it was both useful and applied to what they do and how they conduct avalanche rescue.

*5. Anything else to add on AvSAR or how you've been involved with its development over the years?*

I have been involved in the Pro/Rec split and the development of the AvSAR guidelines since the concept was introduced with the white paper. I'm excited to finally see this program see the light of day and look forward to the positive impact it will have on our industry.

Jim Donovan

*1. What is your professional background?*

I am the Executive Director at Silverton Avalanche School, a nonprofit educational school devoted to avalanche awareness, education, and training from the recreational to the professional.

*2. Describe the type(s) of courses you are currently offering that meet similar criteria and how they will be adapted once the guidelines are accepted.*

We offer an advanced rescue course that covers complex rescues appropriate for ski patrol, mountain guides, and organized rescue groups. We have been using the draft Pro AvSAR Proficiencies and Guidelines as a skeleton for our courses.

*3. Who are the most reliable consumers of this kind of instruction, and how do you meet their needs currently?*

Ski patrol and mountain rescue groups are the most common customers. Professional guides also benefit from practicing more team-based approaches, since they are often working solo.

*4. Anything else to add on AvSAR or how you've been involved with its development over the years?*

We see the Pro AvSAR as a great progression for the American avalanche community. Frankly, Europe and Canada are way ahead of us in terms of organization, training, and technology.

The Silverton Avalanche School is a member of the International Commission for Alpine Rescue, and we sit on the Avalanche Rescue Commission.

We are bringing back the best practices developed by rescue groups from around the world. Keep a look out for the these best practices at http://mountainsafety.info/.

## Steve Achelis

*1. What is your professional background?*

I am the former commander of the Salt Lake County Search and Rescue Team where I participated in hundreds of backcountry rescues including two dozen avalanche accidents. I am on the board of the Utah Avalanche Center, a part-time ski patroller at Brighton Resort, and teach avalanche, wilderness medicine, and rope-rescue courses for several agencies.

*2. How do you see the AvSAR course fitting into the current landscape of professional education?*

The AvSAR course is a great addition to the A3 curriculum. I see it transitioning people from companion/partner rescue, where most guides and patrollers are strong, to group rescue where avalanche professionals are expected to be strong. Establishing a leadership structure early in the rescue, limiting redundant operational tasks, ensuring that tasks are not overlooked, and thinking two (or more steps) ahead are key operational skills during avalanche rescues.

*3. Describe your involvement with the guidelines of Pro AvSAR?*

I reviewed the draft Pro AvSAR guidelines in late 2017. As I reviewed the guidelines, I reflected on my avalanche-rescue experiences, from the small, quickly resolved missions to the multi-day, multi-victim, multi-jurisdictional missions. During this process I asked myself the proverbial questions: "What did I do right," "Where did I fall short," and "What do I wish I had known before those missions." I am hopeful my input into the guidelines will help class participants as they seek to improve their professional-level rescue skills.

*4. What insight do you have for consumers of this type of training?*

One insight, and it is so well known that it has become a cliché, is that "preparation leads to performance." But it's true. The more we practice, the more we ask ourselves "what if" questions, and the more we try to discover the essentials that lead to successful missions, the better we will perform when called upon. You can't be over prepared.

## Eric Murakami

*1. Your professional background?*

I have 20 years experience as a local patroller. I have worked the last six years as a Snowbird Snow Saftey Supervisor, and recently moved up to become the Assistant Director of Snow Safety.

*2. What kind of in-house avalanche rescue training do your patrollers currently go through?*

Hasty, transceiver single/complex, RECCO, probing organized/spiral, strategic shoveling, rescue dog drills, and helicopter protocols.

*3. How would the addition of a dedicated professional avalanche rescue course benefit your employees?*

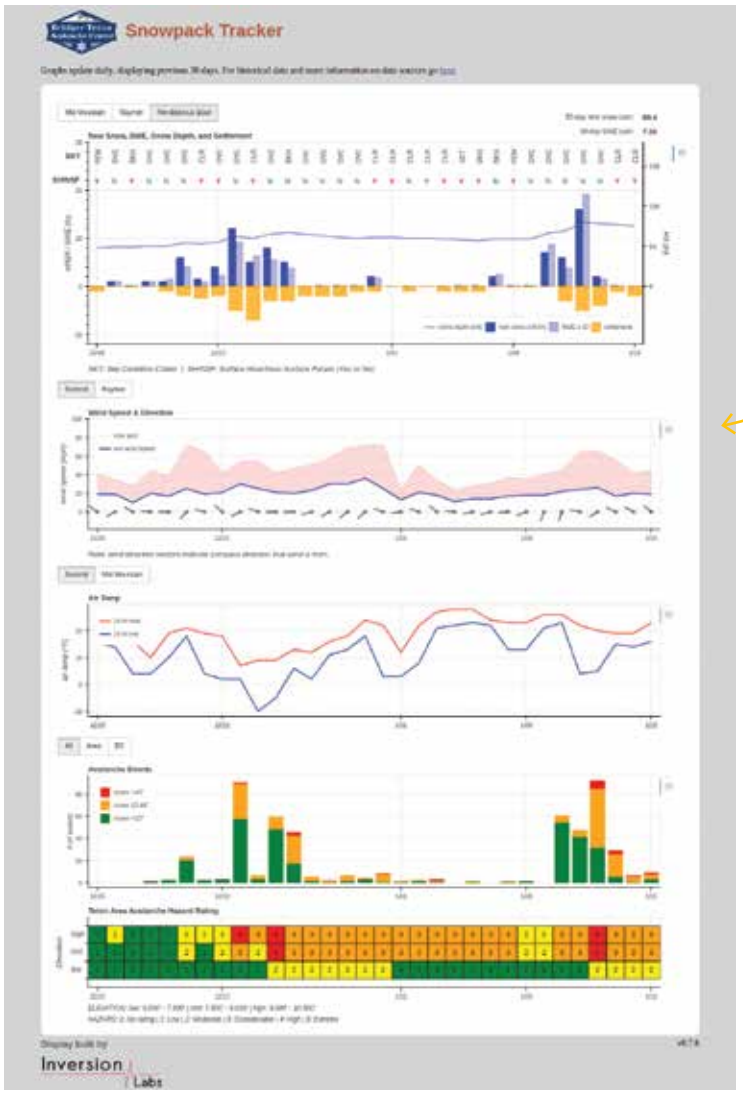
I rely on our patrollers to be strong avalanche forecasters, and I support all avalanche education. However, a course dedicated to avalanche rescue would be hugely beneficial, and I feel it would complete the formal avalanche-education process.

*4. Anything else to add as a potential consumer of this kind of training? As an employer, what would be most valuable?*

In a perfect world, I'd like to have a succession of in-house courses to provide a consistent level of training for all of Snowbird's ski patrollers. ▲

# NEW DATA VISUALIZATION TOOL FOR THE BRIDGER-TETON AVALANCHE CENTER

BY PATRICK WRIGHT & TOBEY CARMAN




**New for the** 2017-18 season, the Bridger-Teton Avalanche Center (BTAC) website includes tools for interactive display of weather and avalanche data. Developed by Inversion Labs for BTAC, these tools include two products for display of 24-hr data. The "Snowpack Tracker" is intended for routine daily use, providing a view of primary weather and avalanche data for the previous 30 days. For the research-oriented user, the "Historical Graphs" leverage the BTAC's unique historic database, providing graphs of daily data for any season back to 1974. Both tools update daily and are available to the public via the BTAC website under "Weather & Snow Data."

These tools fill the need for visualization of data beyond raw weather variables and provide display using a modern, interactive visual platform. Features include:

- Graphs of derived weather variables, including snow settlement, new snow density, cumulative multi-day precipitation totals, and 24-hr wind totals.
- Display of non-weather variables, including avalanche events and daily hazard rating.
- Interactive features, including a hover tool to display data values, zoom/pan tools, and a date-range selection tool.
- Desktop and mobile displays

Although developed with forecasting in mind, these tools have received regular use by avalanche education providers, highway avalanche technicians, and the public, with traffic around 40-50 visits per day during the 2017-18 season. Building on the popularity of previously developed tools, the Snowpack Tracker layout incorporates elements from an Excel sheet originally developed by Ian McCammon, Bill Nalli, and Craig Patterson.

The world of avalanche-data visualization is evolving rapidly, with many centers in the US now providing tools either customized for their operation, or utilizing standardized products (the Sawtooth, Flathead, and Sierra Avalanche Centers are actively collaborating on a similar product provided by Snowbound Solutions and the NAC). Based on community and forecaster input, the BTAC tools will continue to see improvement, so check back soon for new features.

Contact Patrick Wright at pwright@inversionlabs.com for more details. ▲

After spending four summers completing graduate research on the Greenland Ice Sheet, **Patrick Wright** is currently co-owner of Inversion Labs, working on projects spanning from avalanche studies to air quality. When not writing computer code or doing field work, Patrick can be found on skis or on foot exploring the mountains of northwest Wyoming. Patrick holds MS degrees in Atmospheric Science (2012) and Glaciology (2015).

**Tobey Carman** lives in Anchorage, Alaska, and works as a software engineer for the Institute of Arctic Biology. In his free time he is usually skiing with his wife, Cortney, or working on new approaches to merge earth and data science. Tobey received a Masters in Software Engineering in 2012 from the University of Alaska Fairbanks.

# SHEAR QUALITY OR FRACTURE CHARACTER WITH AN EXTENDED COLUMN TEST— NO LONGER IN SWAG OR SNOWPILOT

BY RON SIMENHOIS, DOUG CHABOT, KARL BIRKELAND AND ETHAN GREENE

**The 3rd Edition** of *Snow, Weather and Avalanches: Observation Guidelines for Avalanche Programs in the United States* (SWAG) was published in the summer of 2016 with a few updates. One notable change is the removal of Shear Quality (SQ) and Fracture Character (FC) for the Extended Column Test (ECT) and the Propagation Saw Test (PST). This change has caused consternation with some professionals, including SnowPilot users who no longer have this field alongside the ECT.

The reason to remove it is simple: SQ and FC were developed as a proxy for crack propagation. With the addition of the Extended Column and Propagation Saw Tests, the proxy is no longer needed. The ECT and PST aim to provide a direct index of crack propagation. Recording SQ/FC adds nonessential and redundant information to the already complicated task of evaluating slope stability.

Some SnowPilot users would like to use SQ as a way to describe the motion of an ECT after fracture. However, with an ECT, the movement of the block into the pit does not depend on crack-propagation propensity, but rather on the balance between slope angle and friction. Given a steep-enough slope, the ECT block will almost always slide regardless of crack-propagation propensity. On the other hand, on low-angle slopes an ECT block will remain in place even with a Sudden Fracture or Q1 shear. SQ/FC is not—and was never meant to be—a good test to demonstrate block movement, since it relies on slope angle vs. friction rather than crack-propagation propensity. Instead, we encourage people to describe the block motion in plain language whenever it is needed.

SnowPilot allows the observer to include comments on a specific snowpit test and for the snow profile as a whole. These are very useful features and allow the observer to document notable observations that don't fit into one of the standard coded fields. ▲

**Ron Simenhois:** Avalanche forecaster for the Colorado Avalanche Information Center at the Eisenhower Tunnel; creator of the ECT.
**Doug Chabot:** Director of the Gallatin National Forest Avalanche Center; founder of SnowPilot.
**Karl Birkeland:** Director of the National Avalanche Center; introduced Shear Quality, on SWAG working group.
**Ethan Greene:** Director of the Colorado Avalanche Information Center; Chair of the SWAG working group.

## UAC PODCAST

**This fall, the Utah Avalanche Center** commenced its first season of the UAC Podcast—helping keep people on top of the Greatest Snow on Earth instead of buried beneath it. It's hosted by UAC forecaster Drew Hardesty and produced by RadioWest's own Benjamin Bombard. Interview topics have run the gamut from avalanche accidents and PTSD to risk management and recreating like a pro with guests such as Alta Snow Safety's Dave Richards, IFMGA guide Anna Keeling, and retired UAC forecaster and Jenny Lake climbing ranger Tom Kimbrough. All these podcasts can be found on iTunes, Stitcher, or on the UAC blog page. Tune in during your spring road trips or while hanging out in the backyard.

# D'BEST GOES D'BEAST

BY NICK D'ALESSIO

**I am updating** the **D'BEST** beacon check to the improved **D'BEAST**. The **D'BEST** beacon check was originally published in the September 2016 issue of TAR and was a new approach for effective beacon check. It works really well and does not let you skip potentially life-saving steps before you leave the trailhead, which I see happen way too often.

Performing a D'BEAST beacon check before a backcountry day. *Photo Nick D'Alessio*

This year—thanks to Eeva Latosuo (Alaska Pacific University and Alaska Avalanche School)—the **D'BEST** beacon check has evolved to **D'BEAST**. The "A" is for "Airbag or AvaLung." Is your AvaLung out? If you or anyone in your group uses an airbag backpack, make sure to check that the handle is out, and if using a JetForce Technology airbag, make sure it's turned on. If you are going to spend a lot of money and carry the extra weight of an airbag pack but do not have the handle out, your airbag is worthless. Here is the new protocol:

**D**—Display (any errors on your display screen?)
**B**—Battery (check your battery strength; replace your battery at 50%)
**E**—Electronics (all electronics stored at least 20cm away, phone to airplane mode and turned off)
**A**—Airbag/AvaLung (is your airbag handle out and activated? Is your AvaLung out?)
**S**—Search (check your group's search function)
**T**—Transmit (have your group properly stow their beacons and check that each person is transmitting)

Lastly, make sure the group leader switches their beacon back to transmit mode and stows it properly.

Using the **D'BEAST** acronym is an easy way to ensure that you do not skip important steps while starting your day skiing, snowboarding, snowmobiling (aka snowmachine in Alaska), or engaging in other mountain travel. I use **D'BEAST** every single day I go out, whether teaching avalanche courses, backcountry guiding, heli-ski guiding, or skiing with my friends on a personal day. Let **D'BEAST** be your way of doing a safe and effective beacon check too. ▲

Nick D'Alessio *is an AMGA ski guide based out of Girdwood, Alaska. Living to ski, he stays active guiding for his own company, Remarkable Adventures, which is part of the new Alaska Guide Collective. Nick also stays busy teaching with the Alaska Avalanche School and heli-ski guiding with Chugach Powder Guides. His favorite place to ski is where he has never been before.*

# THE 4TH DIMENSION OF COMMUNICATION: SOCIAL MEDIA

BY LINDSAY MANN

"All of my relationships are influenced by social media, even with my parents who are like 50. Phones and social media are the 4th dimension of communication," Reed Carlman, a 17-year-old Jackson Hole native, stated this fall while sitting on the Youth and Media Panel during the Wyoming Snow and Avalanche Workshop (WYSAW) October 2017.

This panel served as a forum to discuss how our phones—and specifically social media—influence our decision-making in the backcountry. How is this tool affecting the upcoming generation of backcountry skiers and snowboarders?

Reed was one of six people who sat on this panel this fall. The other panelists included two of Reed's peers, B.B. Hall and Emery Rheam. Both B.B. and Emery are members of the Jackson Hole Ski and Snowboard club, competitive ski racers, backcountry enthusiasts and high school students. Garrick Hart, physics teacher and Exum guide; Keely Kelleher, founder of Keely's Ski Camp for Girls and professional skier; and me, Lindsay Mann, ski racing coach and mountain guide also sat on this panel led by Matt Hansen, editor of *Powder Magazine*.

Lindsay Mann and Keely Kelleher talk the girls through the daily plan during one of their Iceland Backcountry Ski Camps. *Photo Crystal Sagan*

Prior to the panel, Garrick Hart surveyed 578 Jackson Hole High School students about their phone use. His questions ranged from their age when they got their first smartphone to their current Snapchat score. The survey showed that snapchat and Instagram are the most popular social media apps. 93% of the students use Snapchat, and their average score is 105,000. If you aren't familiar with Snapchat, this score means that, on average, each Jackson Hole High School student has sent or received 105,000 images through the application.

The average student spends more than an hour a day on social media, and a quarter of the school spends more than 10 hours a week!

Since spring 2007 when the first iPhone was released, the smartphone has changed the way we relate to our world. The current generation of teenagers has never lived without internet access, and they are proficient and prodigious consumers of social media. How does this affect our roles as backcountry travelers, guides, and avalanche instructors?

Professional skiers are contractually obligated to post videos and photos to their social media accounts. For example, Teton Gravity Research has 277,000 followers on Instagram; Griffin Post, professional skier and TGR athlete has 29,700. The American Avalanche Institute has just over 5,200 followers, and the American Avalanche Association has 206 followers. How do these media influence youth in the backcountry?

Hart's survey showed that 55% of Jackson Hole High School students have made risky decisions in order to get a good photo to post on Snapchat or Instagram. B.B., Reed, and Emery all admit that social media has made them feel badly enough about themselves that they've deleted these apps for periods of time. They get FOMO (Fear Of Missing Out) by using these apps, yet paradoxically, they also experience FOMO when they aren't on the apps. On a positive note, they say that posting photos on social media has allowed them to encourage their peers to get avalanche training before going into the backcountry.

After waking up to wind and new snow, Keely's backcountry ski campers explored a new area in Iceland. After starting out the day not knowing what kind of conditions they would find, the girls celebrated a great day of fun skiing, demonstrating that a change of plan can sometimes be the start of a new adventure. *Photo Crystal Sagan*

TGR athlete Griffin Post says that he infuses safety-conscious messaging into his posts, yet at the end of the day, action photos sell. So he tries to create a balance by sharing some of his near misses and lessons learned in the backcountry along with the awe-inspiring, cliff-dropping images.

Panelist Keely Kelleher is an ex-World Cup ski racer, Blizzard/Tecnica athlete, and founder of Keely's Ski Camp for Girls where she hosts ski racing camps, big mountain camps, and backcountry camps for teenage girls. As a role model to girls, Keely is acutely aware of her presence and influence on social media. During her camps, she is often able to interact with girls who have "liked" the photos or videos she posts to social media, which gives her a larger opportunity to share the story behind the images.

After sitting on the panel, I was left with a lot of ideas from what B.B., Emery, and Reed had to say, but I was also left with a lot of questions about how we move forward. As the statistics show, it is more likely that these teenagers follow TGR or some of the skiing stars in these movies, rather than the American Avalanche Institute. Is there a way that we can continue to work with these movie companies to convey more safety messages versus just seeing someone being caught in a large avalanche in a movie?

How can we continue to make sure that we address the influences of social media when we are making decisions in the backcountry in avalanche courses? And do we need to recognize that social media is an incredible education tool that is being underutilized?

As a guide and coach, these are things that I am constantly considering when I talk to these teenagers and even younger athletes. I ask questions such as, "What does this image make you think of when working with younger athletes," "Why do you think we were able to get this rad photo on this day," or "Where do you think the person was when they took this amazing photo?" As avalanche educators, I think that there is a lot that we can continue to learn about how social media is influencing the current and upcoming generation of backcountry users and start using it as a better educational tool. ▲

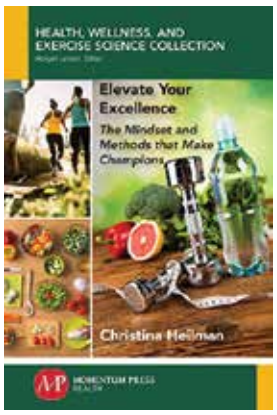
**Lindsay Mann** grew up on the East Coast. She ski raced competitively in high school, which exposed her to mountains all over the world. Her passion for skiing took her to Dartmouth College where she helped her team win an NCAA Championship in 2007. Lindsay currently works for the Jackson Hole Ski and Snowboard Club as an alpine ski coach, and she also works as a ski guide and coach for Keely's Ski Camp for Girls. She has previously worked for Rainier Mountaineering Inc., and San Juan Mountain Guides, teaching avalanche courses, and ski guiding in the Pacific Northwest.

# BOOK REVIEWS

## Elevate Your Excellence: The Mindset and Methods That Make Champions

By Christina Heilman, PhD, ATC, CSCS

**In her book,** *Elevate Your Excellence: The Mindset and Methods that Make Champions*, Christina Heilman, PhD, ATC, CSCS, aims to provide the reader with the science behind and the mental skills to work toward optimal performance. While the book dances primarily within the realm of sports psychology, I would put forth that the mental skills presented in Heilman's text easily cross-pollinate into the personal, professional, and recreational realms of life.




Heilman's book begins by explaining the importance that mental skills carry in any kind of performance. She sells the reader on why mental skills are important. The remainder of the book is organized into five separate chapters, describing the skills of Motivation, Goal Setting, Performing under Pressure, Relaxation and Energization Strategies, and lastly, Imagery.

Throughout the book Heilman provides case studies to support the theories presented, and guided exercises provide the reader with a sample of the skill in action.

As avalanche and snow-science professionals, we have come to learn that human factors can be a major player in our decision-making and can be a determining factor in whether we come home or not. I believe that through a better awareness of the "micro-forks," smaller decisions that ultimately lead to a main trajectory, we will ultimately be able to make decisions that are intentional and productive toward our goals.

Psychology, as Heilman defines it, is based on our perceptions of a situation. The psychological tools that Heilman uses help the reader to remember why they care about their activity, and also teach successful development and strategies with which to achieve those goals. I used the exercises in her book to remind myself of why I love snow, and of the ideas and aspirations that led me to want to work in the avalanche industry. Some days in any job—be it a rough client, poor conditions, or an incident—can cause us to forget why we started down this path. These instances can also lead us backward from our intended destination. To this, Heilman asks us to recall the reason for our initial fire, and she goes on to explain the difference between healthy and malignant goal types. She describes the differences between anxiety, stress, and arousal. Placing definitions and examples to these concepts increases our situational and self-awareness so that we can sooner take action when we feel that bubble of pressure begin to well up deep inside.

For our increased awareness of stress we are provided with tips helping us to energize and relax, allowing us to be able to step back from front line and to be able to process the situation at hand. I can certainly think of a few mitigation mornings in which stepping back would have provided a greater chance of a successful perspective, or in which energizing a bit more would have allowed me to sample the rich flavors of an issue with a more satisfying bite.

Put simply: Heilman's book is well laid out and full of helpful tools and insight. I recommend it for folks who deeply love what they do but are searching for a key to implementing their vision. *Elevate Your Excellence* is easy to read, so it's easy to keep focused on the general goal at hand: being able to better develop into the type of snow scientists, forecasters, guides, educators, and humans who—when we are the most optimistic and the least concussed by our oppressive gremlin thoughts—we want to be.

*— Lindsey Fell*

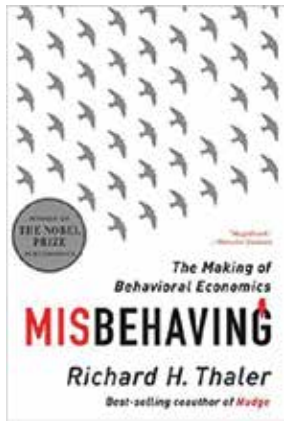
**Lindsey Fell** calls the Tetons her home, and is the Assistant Snow Safety Director at Grand Targhee. Along with romping in and thinking about the snow, she enjoys billy-goating among the high peaks, and perfecting the crumb in her whole wheat sourdough bread.

## Misbehaving: The Making of Behavioral Economics

By Richard Thaler

**To better understand** how human decisions contribute to avalanche accidents, you may need to consider studying behavioral economics.

In 2017, it was surprising that the Nobel prize for economics was not awarded to a traditional mainstream economist, but instead was given to behavioral economist Richard Thaler. Thaler was honored for his pioneering work on how humans make decisions, especially bad ones. It seems that people commonly make irrational decisions, but in often recognizable and predictable patterns. Behavioral economists have transformed the study of economics. Their insights hold lessons for backcountry skiers and avalanche practitioners too.




Thaler's work was built on the groundbreaking insights of Amos Tversky and Daniel Kahneman (Nobel Prize in Economic Sciences in 2002). Kahneman's 2011 book, *Thinking Fast and Slow,* is on the reading list of many avalanche workers. Thaler's two books *Nudge: Improving Decisions about Heath, Wealth, and Happiness* (with Cass Sunstein) and *Misbehaving: The Making of Behavioral Economics* are likewise valuable reading.

Many mainstream economists assumed that people made financial decisions in a perfectly reasoned and logical manner. Thaler called these super-smart people, "Econs," our hypothetical ideal decision-makers. In one example, our hypothetical Econ would rationally decide to devote the most time to work for the highest wage. In a study of taxi drivers, Thaler found that just the opposite was true. On days when a cabbie earned the highest pay, the cabbie decided to leave work early. Conversely, on days when business was slow, drivers stayed on the road longer, hoping to make up the shortage. Thaler discovered that drivers had an earning goal for each day of work. If a driver met their goal early (for example on rainy days) they will return the taxi to the garage and go home early. On sunny days when few people were hailing cabs, the driver might decide to stay on the road a bit longer hoping to eventually reach their monetary goal. Thaler thought that taxi drivers were "misbehaving." Why not continue working on the busy day and go the full daily shift on the day you are raking in the money and quit early on the slow days?

*If you ever head into the backcountry with a target for riding a certain amount of vertical you may fall into a similar trap: staying out and pushing for your goal when circumstances are working against you.*

Thaler observed that an individual's response to gain or loss is inconsistent. An Econ would logically decide how much effort he wanted to invest for the reward of saving $10. We all have friends who will drive across town to save $10 on a tank of gas. Compared to the relatively small cost of a tank of gas, a $10 savings seems like something our friend might boast about. As the total cost of the purchase becomes larger, the saving of a mere $10 starts to seem less significant. If the purchase is a large one (e.g., television, car, house), the person who drove across town to save on fuel might not go around the block to save $20 on a $1000 television or would probably never notice an extra $20 fee on a house purchase. It seems that people think of savings as percentage—saving 20% on a tank of gas is more valuable that saving 2% on a TV, even if more money is saved on the TV, an effect that car salesmen and real estate brokers use to great advantage. (Full disclosure, the author has been a licensed real estate broker in Colorado for 35 years.)

*The lure of skiing a sketchy line may be greater if those are going to be the only turns of the day.*

Thaler also observed the differing responses to risk acceptance or mitigation which he called the

"Endowment Effect." In a hypothetical exercise he asked the questions:

A. You've been exposed to a fatal disease with a 1-in-1000 chance of dying (a quick, painless death). How much would you pay for a vaccine that would guarantee your survival?
B. A local hospital is doing a research project on paid subjects. Your chance of death if you participate is also 1-in-1000 (again quick and painless). How much must you be paid to agree to participate?

In a world of an Econ, the trade-off between risk and money would be identical. However when the question was posed to test subjects, the response to question A was around $2,000 and question B was $500,000 or 25,000% greater.

I've used a variation of the "Endowment Effect" in a decision-making exercise for avalanche students. I present two groups with different scenarios asking them to make a decision about whether or not to accept the avalanche risk involved on a hypothetical hut trip. One group is told that they paid for the trip in advance (they lose their money if they don't go), and a second group is told that someone else paid for the trip and they can go "for free." Regularly the group that faces losing their money chooses to go to the hut, and the group that has the chance to go for free decides to stay at home.

*— Thomas White*

Thomas White *is an AIARE course leader and guide for Colorado Mountain School based in Boulder, Colorado. He grew up around Summit County Colorado and started skiing backcountry there while in high school. He's worked as an instructor, coach, and patroller. Time with clients in the backcountry is the most fun.*

"When the weak layers you've been babbling about like a broken record all freaking winter finally verify." —Brett Kobernik.

A photo by Mark Staples of Brett Kobernik taking a photo of Trent Meisenheimer investigating a crown on the Utah Skyline.

## SCENARIOS FOR AVALANCHE COURSES BASED ON THE BOOK *MISBEHAVING*

### Procedure:

The problems below contains all the information you need to make a choice for your group. After reading each problem, thoughtfully weigh your options to reach a consensus decision and answer the question below.

### Blue Sky Hut Problem:

Several months ago, your group got lucky and were able to reserve the popular backcountry hut on Blue Sky Mountain for an overnight trip that is scheduled to begin today. If your trip is canceled you will lose the $420 cost of your reservation. Your group's plan is to use the hut as a base for exploring the wide variety of terrain around the area. The trail to the hut is six miles long with an elevation gain of 850 vertical feet.

Last night a midwinter storm deposited 16" of new snow over the trail to your destination hut. The snow fell on a settled layer of snow from a storm a week ago. Before yesterday's storm, the forecast danger for the zone was Low (Level 1). This morning the forecast danger level for the zone is Moderate (Level 2) with pockets of Considerable danger (Level 3) on easterly aspects. The trail to the hut crosses an open slope barely large enough to produce a D2 slide with a maximum slope angle of 30 degrees and a northeast aspect. There are no terrain traps below or steeper terrain above the slope.

Your friend, who works as a forecaster for the local avalanche center, tells you that the chance of no avalanche on the trail to the hut is 90%.

### Question:

Will your group travel to the hut today?

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### Storm Mountain Hut Problem:

A friend called you last night with an unexpected opportunity that your group is free to take advantage of. He has paid $420 for a reservation in the popular backcountry hut on Storm Mountain. It's too late to cancel, and he can't use the reservation because of sick child. Your group's plan is to use the hut as a base for exploring the wide variety of terrain around the area. The trail to the hut is six miles long with an elevation gain of 850 vertical feet.

Last night a midwinter storm deposited 16" of new snow over the trail to your destination hut. The snow fell on a settled layer of snow from a storm a week ago. Before yesterday's storm the forecast danger for the zone was Low (Level 1). This morning the forecast danger level for the zone is Moderate (Level 2) with pockets of Considerable danger (Level 3) on easterly aspects. The trail to the hut crosses an open slope barely large enough to produce a D2 slide with a maximum slope angle of 30 degrees and a northeast aspect. There are no terrain traps below or steeper terrain above the slope.

Your friend, who works as a forecaster for the local avalanche center, tells you that the chance of an avalanche on the trail to the hut is 10%.

### Question:

Will your group travel to the hut today? ▲

# WHAT WERE YOU THINKING!?

## *impulse decision-making: a contributor to avalanche accidents?*

BY ERIC KNOFF

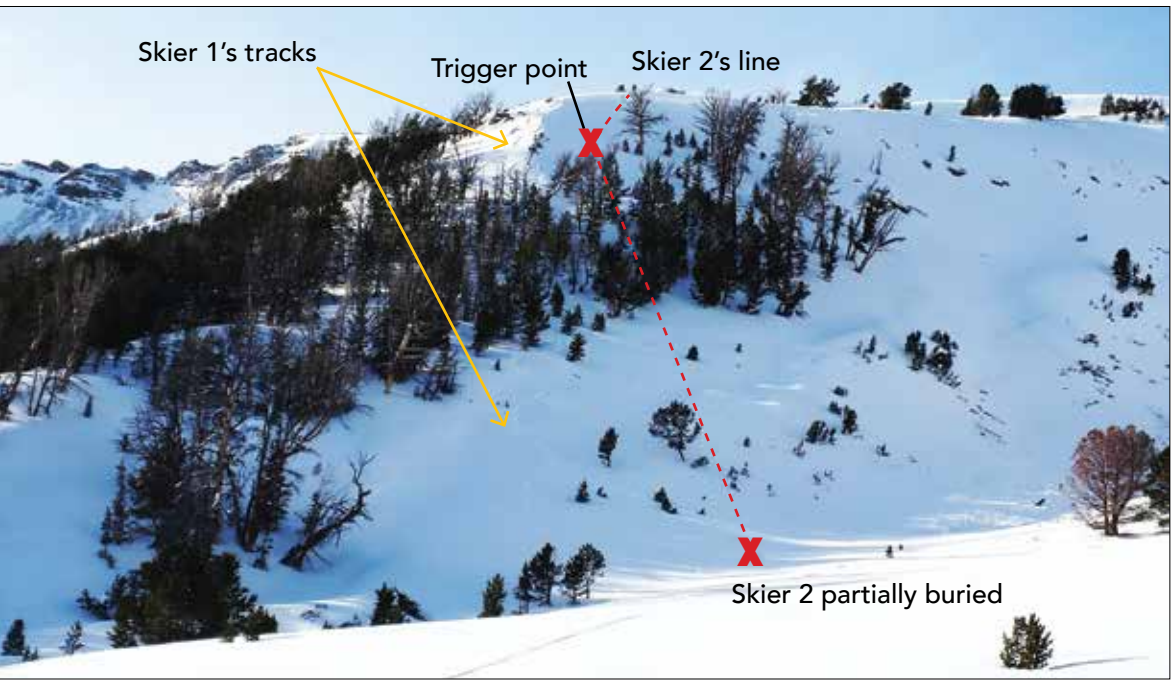
**Impulse decision-making may** lead backcountry travelers into harm's way. When riding in the backcountry, one bad decision can offset multiple good ones. Looking at avalanche accidents through this lens, a question arises: Were the decisions that contributed to an avalanche accident made with thought and measurable information, or were they made impulsively?

In avalanche accidents, it's well documented that the victim or victim's party often observed red flags such as new snow and wind, cracking/collapsing of the snowpack, or recent avalanche activity prior to triggering an avalanche. If obvious clues of instability are present, especially for those educated in avalanches, why are decisions made to proceed in avalanche terrain?

***Once you turn the corner and act impulsively, your only safety net is luck, which does not ensure a long and safe career in the backcountry.***

Impulse decision-making may have led to a fatal avalanche accident that occurred outside the Yellowstone Club near Big Sky, Montana, in January 2016. This incident involved a party made up of Montana State snow science graduate students and two Yellowstone Club patrollers. The incident occurred when a member of the party deviated from the original plan of skiing a low-angle ridge and jumped a 10-foot cornice onto a 38-degree slope. The slope fractured on buried depth hoar, carrying the skier though a group of trees, and killing him due to trauma.

Was the decision to jump the cornice onto a steep slope made thoughtfully, or was it made impulsively? Evidence suggests that the skier had intention to ski the safe line during the group discussion, but acted on impulse which led to the fatal mistake.




This picture was taken by skier 1 moments before skier 2 jumped the cornice. You can see the first skiers tracks on the planned descent route to the left of the steep slope. The accident occurred when the next skier deviated from the original plan and jumped the cornice onto the steep slope to the right of the low-angle ridge. The slope fractured and strained the skier through the thick grove of trees in the center of the slope. The skier died of trauma.
*Photo C. Bilbrey*

We are all susceptible to impulse decision-making. I recall a personal impulse decision in the backcountry that resulted in a close call. My partner and I were standing on a steep rollover that appeared to be wind loaded. I watched my partner avoid the steep rollover and ski poor conditions down a safe, lower-angle slope. Instead of following my partner, I made a spur-of-the-moment decision, jumped into the wind-loaded zone, saw cracks shoot all around me, and was quickly caught in the avalanche. Fortunately, I was not buried or injured and skied out of the debris. This incident easily could have ended worse than it did.

Fresh snow and the freedom to make our own decisions are two dominant reasons we venture into the backcountry. These factors also have a substantial influence on impulse decision-making. The power and temptations of the backcountry can make us act impulsively, sometimes with dire consequences.

When someone gets hurt or killed in an avalanche as the result of a spur-of-moment decision, all good decisions previously made are moot. Controlling impulse decision-making in a dynamic environment such as the backcountry is difficult but not impossible. Gordon Graham, a risk-management professional, found that many accidents occur during High Risk/Low Frequency events or in avalanche terms, Low Probability/High Consequence.

Gordon Graham breaks the Low Probability/High Consequence category into two subcategories: Discretionary time and Non-Discretionary time. During a trip to the backcountry, very few decisions need to be made spur-of-the-moment. We almost always have the discretionary time to dig a snowpit, observe our surroundings, communicate with our partners, and make

# *decision-making*

Dusk on Ymir Peak. *Photo Laura Adams*

educated, thoughtful decisions. This can help reduce risk exposure during Low Probability/High Consequence events.

We know, however, that unplanned events such as avalanches take place in the backcountry. Nobody wants to be caught in an avalanche, yet hundreds of people get caught every year, resulting in numerous fatalities. If we have the discretionary time to make educated decisions in the backcountry, why do so many people get caught and killed? Is it because of acting impulsively and not taking the time to make educated decisions?

Good decisions require gathering available information. Many times I planned to ski in avalanche terrain, but turned around due to unstable results in stability tests or clues of instability such as cracking and collapsing. Taking the time to process this information and fully discuss it with your partners is critically important.

Once you turn the corner and act impulsively, your only safety net is luck, which does not ensure a long and safe career in the backcountry. Communication with your partners and conscious observations of your surroundings are good ways to mitigate impulsive actions. Digging a snowpit is also a great way to slow down, communicate, and base your decisions on actual data. The action of digging and doing a stability test helps us to avoid impulse decision-making.

Next time you venture into avalanche terrain, ask yourself: Have I taken the discretionary time to make an informed decision or is my next decision impulsive? Just asking that question might help eliminate impulsive actions and reduce the potential for a hazardous situation. ▲

*Photo Jonathan Preuss*

# EXPERTISE, ERROR, AND THE ENIGMA OF PREDICTING RARE EVENTS IN COMPLEX SYSTEMS

BY RUSS COSTA

EXPERT HALO

*Those who know are not full of knowledge;*
*Those full of knowledge do not know.*

**—LAOZI**

**My home straddles** the East Bench fault line on the western edge of the Wasatch Mountains. I think about earthquakes a fair amount. I'm a novice geologist, but I know enough science history and about data analysis of complex systems to understand that I'd likely be no worse than an expert seismologist at predicting when a major earthquake will happen (see Hough, 2009 for an excellent account of the wild world of earthquake prediction). But this isn't because I'm particularly smart, prognostic, or lucky. Consider that I've also spent a lot of time analyzing patterns of electrical activity from human brains in the lab over the last seven years, but I'd be no better than a novice at predicting when an epileptic seizure will occur. In certain systems, especially complex and dynamic ones, the benefits of expertise for prediction about "things that move," as former trader, statistician, and risk analyst Nassim Nicholas Taleb (2007) calls them, are only marginal or even nonexistent. I've also thought a lot about judgment, prediction, and decision-making in "spooky/scary moderate" snowpacks this winter—which is what this essay is actually about. Can we trust our own expertise, or the judgments of experts, about these snowpacks? The answer, like most answers about human behavior (and certain snowpacks), is complicated.

The validity of "expert intuition" has been a major dividing wedge in decision science since the field's inception. The school of naturalistic decision-making (NDM), grounded in psychologist Gary Klein's work with firefighters, has embraced the idea that experts can quickly recognize and react to dangers in certain environments in ways that novices cannot. Critically though, these recognition-primed decisions (RPDs) of experts are fast, automatic, and unconscious; self-reports from experts themselves reveal that they are unaware of why they sensed danger and changed their course of action. In opposition, the heuristics and biases camp, based on the influential work of Amos Tversky and Daniel Kahneman (1974), cautions that the use of fast, automatic, unconscious and "intuitive" thought (called "System 1 thinking," or simply "heuristics") leads to errors (see Kahneman, 2011; see also, McCammon, 2003, for an important application of this concept of heuristics to avalanche accidents). In dangerous environments such as avalanche terrain, these errors caused by the use of heuristics can be costly, even fatal. **Take note when good scientists who generally disagree—and sit on opposite ends of my decision-making bookshelf—come to points of agreement.** In a collaborative work, Kahneman and Klein (2009) agree that we can trust the intuitive judgments of experts if two conditions are met: (1) the environment is sufficiently regular to be predictable and (2) the expert has learned these regularities through prolonged practice. (The latter criterion is important enough to warrant mention here, although it falls beyond the scope of this essay.) Here, I want to focus on the former point; specifically, are snowpacks sufficiently regular to be predictable? The answer, I think, is … sometimes.

The groundwork for the cognitive science of expertise came from studying chess (e.g., Chase & Simon, 1973), which Kahneman (2011) rightfully calls "an extreme example of a regular en-

vironment (p. 240)." Master chess players perceive and remember chess game configurations with impressive precision, and they do it very quickly—faster than slow, analytical ("System 2," for Kahneman) thought can operate. But the world of "things that move" is full of critical errors by experts. Expert financial traders fail to predict market crashes, expert seismologists fail in their predictions of earthquakes, and expert backcountry skiers—and avalanche forecasters—make errors in their judgments about snow stability. It is important to note that market crashes and earthquakes are rare events, or "black swans" for Taleb (2007). Decision theory, and the history of prediction, tells a clear story: Rare events in complex, dynamic systems cannot be predicted, even by experts, and even with the best data. In "spooky/scary moderate" snowpacks, avalanches can be such rare "black swan" events.

The 2016–17 snowpack in Utah, and in many other places in western North America, was a "sufficiently regular environment," where knowledge, information, and expertise could be used to make valid assessments and accurate predictions about stability. This winter of 2017–18 has not yielded such a sufficiently regular environment. What differs? Primarily the presence of a persistent weak layer, which (slowly) develops very complex bonding patterns with new snow layers. It becomes a dynamic system, in which snow stability varies over both space and time. In Taleb's (2007) phrasing it becomes a "thing that moves" sometimes tragically literally. This year in Utah I've read about avalanches occurring on backcountry slopes where experts had analyzed multiple snow pits, and on slopes that had 20 sets of tracks on them. What was different when, or likely where (at a very small spatial scale), that 21st set of tracks occurred? The specific location where the avalanche began from was probably different—slightly but crucially—from where the snowpit(s) had been dug and analyzed. Such low-frequency, high-impact events are the cause of much concern in risk management, precisely because they cannot be predicted, yet can have huge costs. Nate Silver's (2012) distinction between predictions—definitive, specific statements about when and where an event will occur—and forecasts, probabilistic statements over longer temporal and larger spatial scales, is useful here. Avalanches in "spooky moderate" environments are rare, complex, and dynamic events that can be forecasted, but not predicted.

I'm a better psychologist than I am a snow scientist or soothsayer. There's a final situation I want to discuss that is uniquely psychological in nature: when knowledge is not only of marginal value or useless for prediction, but it is also toxic. In a landmark study that shocked clinical psychology, Paul Meehl (1954) demonstrated that expert clinicians were no better than algorithms (which were still not very good) at predicting the future behavior of humans. Taleb (2007) goes further with what became known as the expert problem, calling it "the tragedy of the empty suit," and coupling the incompetence of experts' prediction with arrogance. In essence, the growth in confidence of one's prediction outpaces the growth in accuracy provided by one's expert knowledge (see Krause, 2017, who applies similar logic to avalanche decision-making). Italian snow scientists have recently empirically documented the growth in experts' confidence, noting that it could make expert backcountry skiers and winter mountaineers more susceptible to "black swan" avalanches (Bonini et al., 2015; see also, Stewart-Patterson, 2008, for application to confidence and intuition by expert ski guides). In many respects, this problem parallels the risk homeostasis (or risk compensation) hypothesis, which posits that individuals take more risks because they have better safety equipment, effectively negating (or at least reducing) the safety benefits provided by the equipment. The Canadian psychologist Gerald J. S. Wilde (1982; see also, Peltzman, 1975) is generally credited with this hypothesis, although it is probably best phrased in the American skydiving pioneer (Bill) Booth's Rule #2: "The safer skydiving gear becomes, the more chances skydivers will take, in order to keep the fatality rate constant." This concept has been applied to seatbelts, ski and bicycle helmets, condoms, and many other physical items of safety equipment, including AvaLungs and air bags in the avalanche community. I think knowledge works in much the same way—the more we know about avalanche safety, the more risks we take in avalanche terrain. In predictable snowpacks, this is a good gamble; accidents, of course, will still happen, but risk can be mitigated by our knowledge. But in unpredictable, "spooky moderate," snowpacks, our knowledge may not provide as much safety as we presume it does, and humility in the mountains is, as always, the best approach. ▲

SE facing, Cardiff on the Alta side, triggered with a ski cut. It was a bit bigger than I expected, probably the fourth wind slab I triggered that day. *Photo Mark White*

## REFERENCES


*Bonini, N., Pighin, S., Rettore, E., Savadori, L., Schena, F., Tonini, S., & Tosi, P. (2015). Overconfident people are more exposed to "black swan" events: A case study of avalanche risk. IZA Discussion Papers, No. 9009.*

*Chase, W. G., & Simon, H. A. (1973). Perception in chess. Cognitive psychology, 4(1), 55-81.*

*Hough, S. E. (2009). Predicting the unpredictable: the tumultuous science of earthquake prediction. Princeton University Press.*

*Kahneman, D. (2011). Thinking, fast and slow. Macmillan.*

*Kahneman, D., & Klein, G. (2009). Conditions for intuitive expertise: a failure to disagree. American Psychologist, 64(6), 515.*

*McCammon, I. (2003). Heuristic traps in recreational avalanche accidents. The Avalanche Review 22(2): 888-7926.*

*Meehl, P. E. (1954). Clinical versus statistical prediction: A theoretical analysis and a review of the evidence. University of Minnesota Press.*

*Krause, D. Killing confidence. The Avalanche Review. 35(4).*

*Peltzman, S. (1975). The effects of automobile safety regulation. Journal of Political Economy. 83*

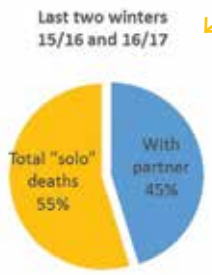
*Silver, N. (2012). The signal and the noise: why so many predictions fail--but some don't. Penguin.*

*Stewart-Patterson, I. (2008, September). The role of intuition in the decision process of ski guides. In Proceedings International Snow Science Workshop, Whistler, BC.*

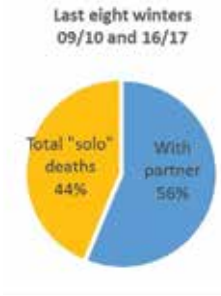
*Taleb, N. N. (2007). The black swan: The impact of the highly improbable. Random house.*

*Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. Science, 185(4157), 1124-1131.*

*Wilde, G. J. (1982). The theory of risk homeostasis: implications for safety and health. Risk analysis, 2(4), 209-225.*






Events leading up to the 1/11 Sun Valley cycle:
Two weeks of high pressure built up a snowpack of 3-4mm dry facets. It was then buried on 12/19, which is a date that would linger in our minds over the next month. The snowpack received numerous small loads until January, when two larger storms came through back to back. The first storm arrived on 1/9, with 8" and 0.64" SWE. The second storm arrived on 1/11 and was the breaking point, with 10" and 0.86" SWE over 10 hours with moderate SW winds finishing to the NW. Overnight, the snowpack turned into a spooky setup with rumbling collapses.

This persistent-slab was remote triggered by a guide from below. He looked up at the slope and decided to regroup further downhill when he heard a large collapse, triggering this SS-ASr-R3/D2-O. The 32° slope spider-webbed across the face and cracks traveled over 800' away. No one was caught or buried. We remote triggered three other slides over the next two days. Please see another photo of this avalanche on page 25. *Photo Chris Cullaz*

## BACK TO THE BASICS

### *a look at how we travel with our partners and how we go uphill*

BY EVELYN LEES AND MARK STAPLES

**Last winter, a** quarter of avalanche fatalities in the US were solo travelers. In addition, a significant percentage of avalanches fatalities in the US happened to people going uphill. Having a partner to perform a rescue and choosing a safe uphill route are two fundamental parts of avalanche safety. We decided to discover how many people in the US were dying solo and how many were dying going uphill.

The initial focus on solo avalanche fatalities brought to mind a handful of snowmobilers where the victim had left the group and was alone at the time of the avalanche. How often was this an issue with skiers and other user groups? What other situations were there when an avalanche victim with partners was "effectively solo?" How often are your partners in a good position to rescue you?

We ended up defining "effectively solo" as situations when you have a partner who can't perform a fast, efficient rescue because they are:

- Out of sight
- Too far away
- Also caught in the avalanche

The numbers from the past two winters shocked us so much that we decided to examine the last eight winters of solo and effectively solo avalanche fatalities as well. Below are the results for both data sets.

**Five out of 10 were effectively solo**

In the last two winters, 54% of people killed in avalanches were either solo or effectively solo. Looking back over eight winters, 44% were either solo or effectively solo.

Some of these victims would have died regardless, due to trauma, but a partner could have made a difference. An effective partner might have dug them out alive. A partner might have stopped the bleeding or taken some other life-saving measure. In a few cases the victims survived the avalanche and were conscious. More importantly than performing a rescue, a good partner may have also questioned the original decision to get on the slope that slid.

### UPHILL TRAVEL FATALITIES

*Evelyn Lees, Christina Raspollini, Linda George , December 15, 2017*

A large number of people died while going uphill during the winter of 2016–17. (Thanks to Christina Raspollini and Linda George for helping sort through the accident reports, doing all the heavy lifting and detail work.)

The risk of accidents while descending is often a focus of backcountry travel and avalanche training and education. However, the risk while proceeding uphill is less known. This study investigated the incidence of avalanche fatalities while backcountry tourers were ascending.

We analyzed data from Avalanche.org for winter seasons 2009–10 through November 2017, focusing on the avalanche fatalities of backcountry tourers and recreationists going uphill.

"Tourers" includes backcountry skiers, snowboarders, snowshoers, and hikers, including those who used motorized means for a limited portion of their ascent. We excluded motorized users including snowmobilers, heli skiers/snowboarders, most climbers, most sidecountry skiers/snowboarders, and patrollers/forecasters caught in accidents while doing avalanche-mitigation work via mechanized access.

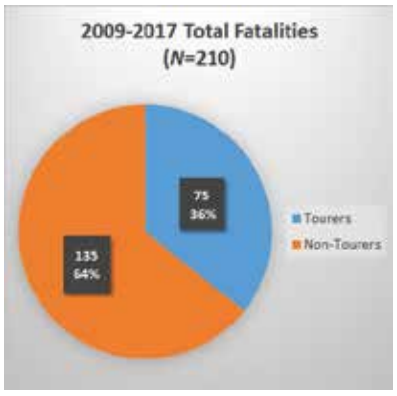
We also defined a category called "Unknown," which included backcountry tourers or recreationists for whom the available information was insufficient to determine whether they were ascending or descending at the time of the accident.

Of the 210 total fatalities from winter 2009–10 through November 2017, we determined that 75 fatalities (36%) fit our criteria as backcountry tourers or recreationists.

Of the 75 fatalities, 24 (32%) were proceeding uphill and 42 (56%) were going downhill at the time of the incident. The remaining nine (12%) were classified as Unknown. Cornice accidents were particularly challenging when trying to determine if the accident "occurred before descent." Many cornice fatalities ended up in the Unknown category.

**Conclusion**

We don't want to discourage true solo travel because it can be very rewarding, but travelers must acknowledge that there is simply no room for error. We want to emphasize using conscious choice when deciding how we travel alone or with partners using fundamental concepts for safe or low-risk travel. 44% of fatalities involved someone either solo or effectively solo. 33% of fatalities occurred on the ascent. These results suggest that backcountry travelers should spend more time considering "where's your partner" and "how are you ascending." ▲




# experience

## ARE YOU EXPERIENCED?

BY ERICH PEITZSCH

Ben's ascent route was on the ridge to looker's left. According to his partner, their intention was to traverse back to the ridge after summiting and not to ski the main face. *Photo Philip Granrud*

**On January 5,** 2017, a close friend of mine died in an avalanche in Glacier National Park. Unfortunately, he wasn't the first friend to die in an avalanche, but this one hit particularly hard. Perhaps it was because I started that day with the two involved in the incident, but I turned around because of illness well before the accident occurred. Or perhaps it was because Ben was a very close friend with miles of experience, figuratively and literally, in the backcountry. He was a well-educated recreational backcountry traveler and also taught avalanche and backcountry skills to aspiring young mountain athletes. This sparked numerous questions about experience and what it truly means to be experienced.

During healthy amounts of processing, I found myself "bridging the gap" between the personal and professional realm. I study and forecast avalanches as a profession, but, when a tragedy like this occurs, it slams into my personal realm. This was a difficult article to write. It wasn't because of the nature of the topic or the accident that sparked my thoughts on it, but rather the fact that I found it difficult to adequately define experience in a way that captures the essence of what we, as avalanche professionals, mean when we say or write "experience." I also wrote to Lynne that I felt like I was simply rehashing a topic that has been widely covered in many publications. I realized that I simply needed to discuss experience in the context of this accident. Lynne also prodded me with:

"Maybe you are struggling because these accidents that we and our friends are involved in don't always have data to refer to; they are visceral and painful and far-reaching, but the stories need to be told. And they need to be told even if they carry the same damn message over and over again, which is how a lot of these accidents seem, year after year."

Well said, Lynne.

So, what is experience? Merriam-Webster defines experience as direct observation of or participation in events as a basis of knowledge. This suggests that experience is the act of gaining knowledge, and time is required to build a large body of knowledge. Yet, the quality of experience seems to be profoundly important. Malcolm Gladwell popularized the 10,000-hour rule in his book *Outliers* (2008), which was based on previous research by Ericsson et al. (1993). Their research suggests that lifelong, deliberate practice (not just "practice") often (but not always) leads to the difference between expert performers and normal adults. They state, "Individual differences in ultimate performance can largely be accounted for by differential amounts of past and current levels of practice."

Ben Parsons. *Photo Erich Peitzsch*

More recently, Macnamara et al. (2014) used empirical evidence to argue that this deliberate practice view is not as important as Ericsson et al. argued. They argue that, while deliberate practice is important, there are likely a host of factors that can explain the difference between elite and non-elite (regardless of field/activity). Additionally, Stewart-Patterson (2008) discusses intuition and the notion that experience doesn't necessarily equate to expertise. So, what does it take to become an expert? And, don't experts still make mistakes? Unfortunately, in the avalanche world, a mistake can be fatal, whereas a mistake playing chess or violin might only cost you the match or first chair in the symphony.

So, can we use this knowledge in the avalanche industry? I certainly think so. Anecdotally, we know that the more time spent mitigating avalanches, forecasting mountain weather, and traveling in the backcountry typically equates to more experience. However, perhaps there is a bit more than deliberate practice to help us understand risk. McCammon (2000) found that overall risk taken by recreationists with more training (as opposed to less) tends to decrease. However, he cautions that a more comprehensive study would include considering relative risk attitudes and the level of training sought by those various levels as well as field experience among different groups. This "field experience" is likely a very important factor, as not all experience is necessarily created equal. For example, in my own career, the experience I gained as a patroller at a Class A ski area was in stark contrast to that gained at a much smaller area where I first began. Mitigating avalanche hazard as a professional forces us to quickly grasp the inherent risk, quickly assimilate any experience we may have, and use this understanding to be better prepared for future missions. As we progress in our careers we also come to deeply appreciate how experience shapes our risk tolerance, both professionally and personally. It's also important to seek feedback from peers and mentors, as this helps develop our decision-making process (Stewart-Patterson, 2010) and may serve as an alternative when we are very close to the line and the slope won't give us feedback.

Ben's experience was vast and formal in nature (i.e., Level 1 and 2s, in-house training where he was a ski-mountaineering coach, and training as a professional firefighter with the Whitefish Fire Department). So, like many of us avalanche professionals, Ben understood risk and, as a firefighter, often traveled into the belly of the beast. Ben and I also talked about having families and how my risk tolerance changed after having two boys of my own and how his was beginning to change as he raised his young son, Rowen. Yet, simply understanding risk and living in a world where we confront hazards on a daily basis doesn't necessarily make us experts at assessing risk in the moment. We can make quick, seemingly benign, instantaneous decisions that have devastating effects, like Ben did by choosing to make one more turn down the slope instead of traversing high. It's one seemingly small decision that, in the past, he likely didn't receive positive feedback for in the form of a close call that allowed him to think "Hmm, I remember when…" Or did he get that feedback in the past, but not recall it at that moment on January 5?

I think this applies to both our personal and our professional world. When we continuously face hazards and successfully mitigate them, our risk tolerance can unintentionally rise, and original tools to combat complacency may not be enough. Bruce Tremper's (2013) plot of avalanche mastery implies a nonlinear rise and fall in confidence in avalanche skills as we progress throughout our careers. Similarly, it seems that our risk tolerance rises until something profound occurs, like a close call or an accident, then we are forced to reassess our own outlook on risk. I might offer that thoughtful debrief on an ongoing basis might help us realize errors in our processes (TAR 36.3).

In conclusion, I realized that there are none. I'm not trying to be flippant, but our process in examining risk and understanding how our own experience plays a role is continuously developing and changing. By nature, it's inconclusive, I suppose. Thus, it's important to qualify our experience, ask ourselves hard questions, and communicate to the non-professional public that experience is important, but it's not the only factor. Many of these thoughts are still very rough, but Lynne asked me to share some of them, and hopefully they can lead to a productive discussion about experience and understanding the limitations of our experience. Sharaf (2008) states, "We need to be able to recognize when our past experiences are relevant, and when they are not." It almost seems like a vicious cycle that not just more, but varied experiences help us determine which ones are relevant. As Don suggests, we need to remain disciplined and allow for a much larger margin of error than we expect.

I'll leave you with a few questions to ponder:

- Where are you in your professional experience?
- How do we communicate "experience" in incident reports and in messaging, in general? As educators?
- What does experience mean to you and how does it shape your decision-making?

Finally, here are examples of definitions of experience from three avalanche professionals at three distinct stages in their career. **Quiz: which belongs to the relatively new guy, the one with 20 years, and the one with 30 years?**

1. **"Experience is regularly recognizing mistakes, big or small, and learning from them. Experience is seeing the big picture and applying it to every decision made in the mountains during winter. Experience is coming home at the end of the day… and going skiing the next."**

2. **"I've found experience to be the pathway between the theoretical and the practical. And very often, it's experiences, good or bad, that allow our decision-making and situational awareness to fully ripen."**

3. **"Regardless of confidence, risk management ALWAYS carries a degree of uncertainty. To establish 'actual risk' and reduce uncertainty REQUIRES habitual evaluation related to avalanche, snowpack, and weather. To reduce vulnerability to established actual risk…must incorporate industry-standard safe practices along with conservative calls related to forecasting and/or terrain management. Bottom line: expect the unexpected, as things are not always what they appear to be."** ▲

**Answer key:** 1. New guy; 2. 20 years experience; 3. 30 years and going strong

## REFERENCES


*Ericsson, A.K., Krampe, R.Th., Tesch-Römer, C. 1993. The role of deliberate practice in the acquisition of expert performance. Psychological Review. 100 (3): 363-406.*

*Gladwell, M.. 2008. Outliers—The Story of Success. Little, Brown. 320 pp.*

*Macnamara, Brooke N., Hambrick, David Z., Oswald, Frederick L. 2014. Deliberate practice and performance in music, games, sports, education, and professions: A Meta-Analysis. Psychological Science. 1-11. doi:10.1177/0956797614535810.*

*McCammon, I. 2000. The role of training in recreational avalanche accidents in the United States. In: K. Birkeland (Editor) Proceedings of the 2000 International Snow Science Workshop, Big Sky, Montana, USA. pp. 37-45.*

*Sharaf, Don. 2018. Transitions. The Avalanche Review 36 (3). pp. 31.*

*Stewart-Patterson, Iain. 2008. The role of intuition in the decision process of ski guides. In: Campbell, S. Conger and P. Haegeli (Editors) Proceedings of the 2008 International Snow Science Workshop, Whistler, Canada, 530-537.*

*Stewart-Patterson, Iain. 2010. What does your gut say and should you listen? The intuitive-analytical decision making continuum in mechanized ski guiding. In: Osterhuber, R., Ferrari, M. (Editors) Proceedings of the 2010 International Snow Science Workshop, Whistler, Canada, 141-147.*

*Tremper, Bruce. 2008. Staying Alive in Avalanche Terrain. The Mountaineers Books.*

*"Experience." Merriam-Webster.com. Accessed February 26, 2018. https://www.merriam-webster.com/dictionary/experience.*


**EXPECT THE UNEXPECTED, AS THINGS ARE NOT ALWAYS WHAT THEY APPEAR TO BE.**

# POCKET RISK MANAGEMENT

BY DOUG KRAUSE

LODESTAR (n) —
1: a star that leads or guides; especially: North Star
2: one that serves as an inspiration, model, or guide

**How bad could it be?** One of the most dangerous paths I know, Eureka, CO. *Photo Doug Krause*

**The most common** thing I hear from folk who are looking to improve their avy savvy is, *"I want to learn how to make better decisions."* That principle is my lodestar. In these venerable pages we began with communication, progressed to situational awareness, then to teamwork; I've got more irons in the fire. Effective decision-making is not a thing you have or lack, it is the sum of best practices that provide a resilient decision support network.

Risk is the chance that harm will be visited upon an exposed element. As skiers, that element is typically me or you. Seems worthy of consideration—I don't want no harm smackin' down my exposure. Risk management is the purposeful identification, analysis, and evaluation of risk. Often, we think of risk management as a systemic concept that entails planning and protocol and people in offices whinging about helmets and slippery sidewalks. There are numerous rule-based risk-management tools for skiers—add the check marks and follow the instructions on your little card. Shouldn't there be a judgment-based form of risk management that you can slip in your pocket and whip out in real time when you so desperately need it? Right here, right now. What the fuck are we gonna do, Cleetus?

I honestly can't recall if I was in Lima, or Silverton, or Wellington—but I had a risk-management-problem. Last summer the Silverton Avalanche School hired me to develop their new AAA pro curriculum. I remembered from the pro trainer workshop, Dallas Glass said over and over that one of the key components of the new program was defining a "repeatable risk-management process." It sounded important. So, when it came time to develop a risk lecture, I figured that winging it was not the way to go. Winging it is decidedly not a repeatable risk management process.

I put on my research cap and recalled something about ISO-something-something defining the international standard for risk management. Seemed like a good place to start. Well, it is, but ISO 31000 also costs 88 CHF (about $100) for a ticket to that PDF pyramid of wisdom. Crap—I thought. $100 risk management? Surely there must be a more affordable way to calibrate our need for steep and deep.

So, I fired up my Googler and, sure enough, the bones of ISO 31000 are readily available. The pirated risk management consists of various flow charts of principles and frameworks and processes. Not really the kind of thing you can stick in your pack and take on a tour. Makes me think of those dudes in their offices, wearing helmets.

Hmmm—I thought—that's my thinking sound. Surely the Canadians have tackled this problem. They seem to have already tackled most of the conceptual avalanche problems that perhaps befuddle and divide we mighty 'Mericans. Indeed, the *Canadian Technical Aspects of Snow and Avalanche Risk Management* (TASARM) devotes several very polite chapters to exactly the subject that bedeviled me. Sadly, they did not fit in my pack any better than ISO 31000. Free, but not portable.

TASARM separates hazard from risk; breaks risk assessment into identification, analysis, and evaluation; then follows that up with risk treatment. Toooo much for my pocket! Do I analyze or evaluate first? Just throw another shot in there and see if it rips. It's probably fine. Just give 'er. What could go wrong? Wait a minute. What *could* go wrong.

*What could go wrong?* I can fit that question in my pocket. What is my avalanche problem? Do I have a reactive wind-slab problem in specific locations that may produce D1-D2 activity? That's what could go wrong. That is hazard identification, and that is the first step I take before exposing myself. Tee hee.

*How bad could it be?* That's a tidy little assessment query too. If something goes wrong, what consequences may churn down upon us? That's how bad it could be. That's risk analysis.

*Geez, now what?* When we have a handle on the hazard and consequences, the wise grasshopper ought to consider what options are available. What forms of risk treatment are available? There are three: acceptance, avoidance, and mitigation. That's dk, not TASARM. Acceptance and avoidance describe different ways of calibrating exposure. Mitigation refers to reducing a hazard. I like to extend that concept to describe measures taken to reduce uncertainty.

By gum, I think that will fit in my pocket! What could go wrong, how bad could it be, and what in tarnation are we gonna do now. Take Conger-san's advice and wrap a margin around your greatest uncertainty, and there you have pocket risk management. It's not a comprehensive risk-management system, but I think it's good enough for dirty powder junkies. Surely better than "I think it's probably fine." The Swiss are precise engineers, and the Canadians are great with standards, but when you need your risk management served up like a TV dinner—'Merica. Don't burn your tongue on that cobbler. ▲

**For your convenience:** Cut along the dotted line, and keep in your wallet, next to your credit cards.

**POCKET RISK MANAGEMENT**

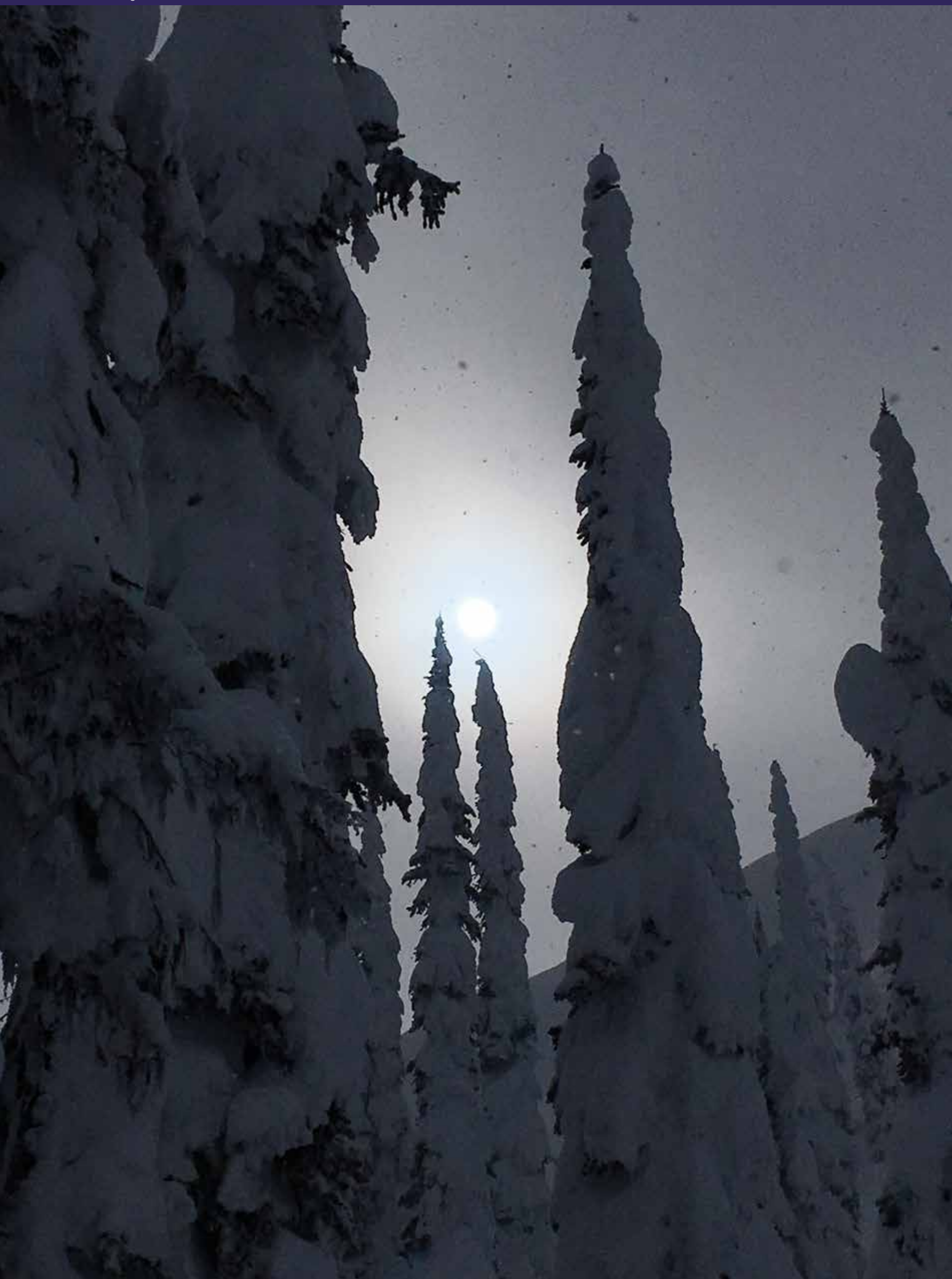
**WHAT COULD GO WRONG?**

**HOW BAD COULD IT BE?**

**NOW WHAT?**

Late Afternoon Light, Selkirks.

*Photo Laura Adams*




*Above photo courtesy Flathead Avalanche Center*

## tracking the DDL across the West

# DECEMBER DROUGHT

**December got darker** and the high pressure persisted. We took photos of surface hoar the size of Doritos on the Thanksgiving crust, muttering, "…if it ever gets a load…" Turns out that the Tetons wasn't the only location tracking that crust/facet combo. As I wished we could push the winter high pressure centered over the West out of the way, I looked at avalanche forecasts from around the West. Sure enough, everyone was high and dry, running low tide. And then the high dropped south just enough for the Kootenays, including Schweitzer (cover photo) and the Flathead, to accumulate a slab. Bingo—our first DDL winners. Missoula, the Tetons, and the Sawtooth weighed in next, while Bozeman ducked that bullet with continuous top-of-continent snowfall. Colorado and the Wasatch were the last to pipe up with their contributions; their snowpack structure was unable to support much on what Greg Gagne wryly noted, "…is not just a DDL, but an O[ctober]N[ovember]DDL."

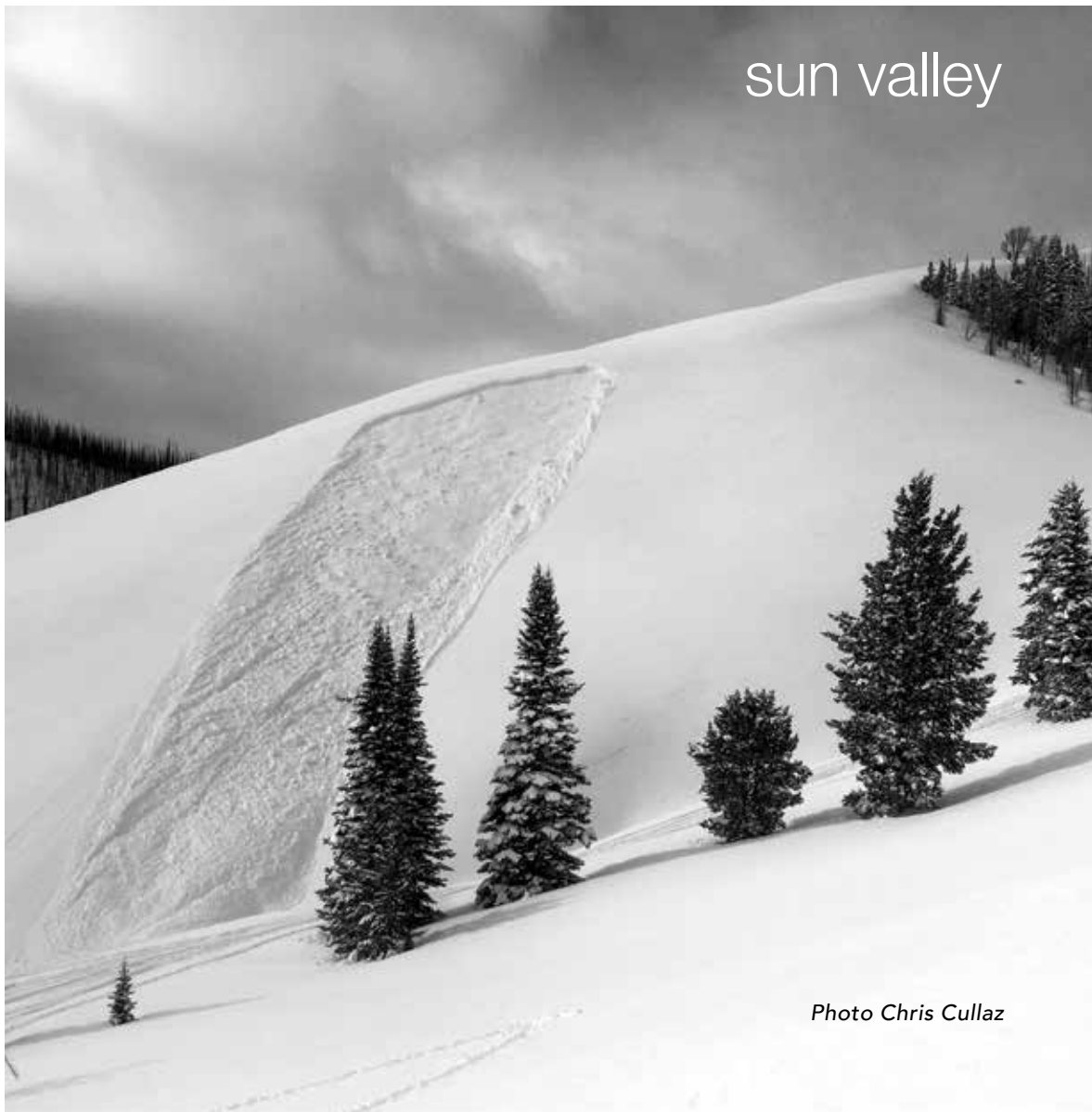
Then I enlisted CAIC forecaster, meteorologist, and previous TAR contributor Nick Barlow to procure weather maps from December and January that graphically show how indeed weather is the architect of the snowpack; you'll find his maps and explanation on pages 26 and 27.

*—Lynne Wolfe, Editor*

The snowplow triggered this slide off to the side of the BCC road when it threw snow off the road, facets at the ground on a super sensitive day. *Photo Mark White*

wasatch

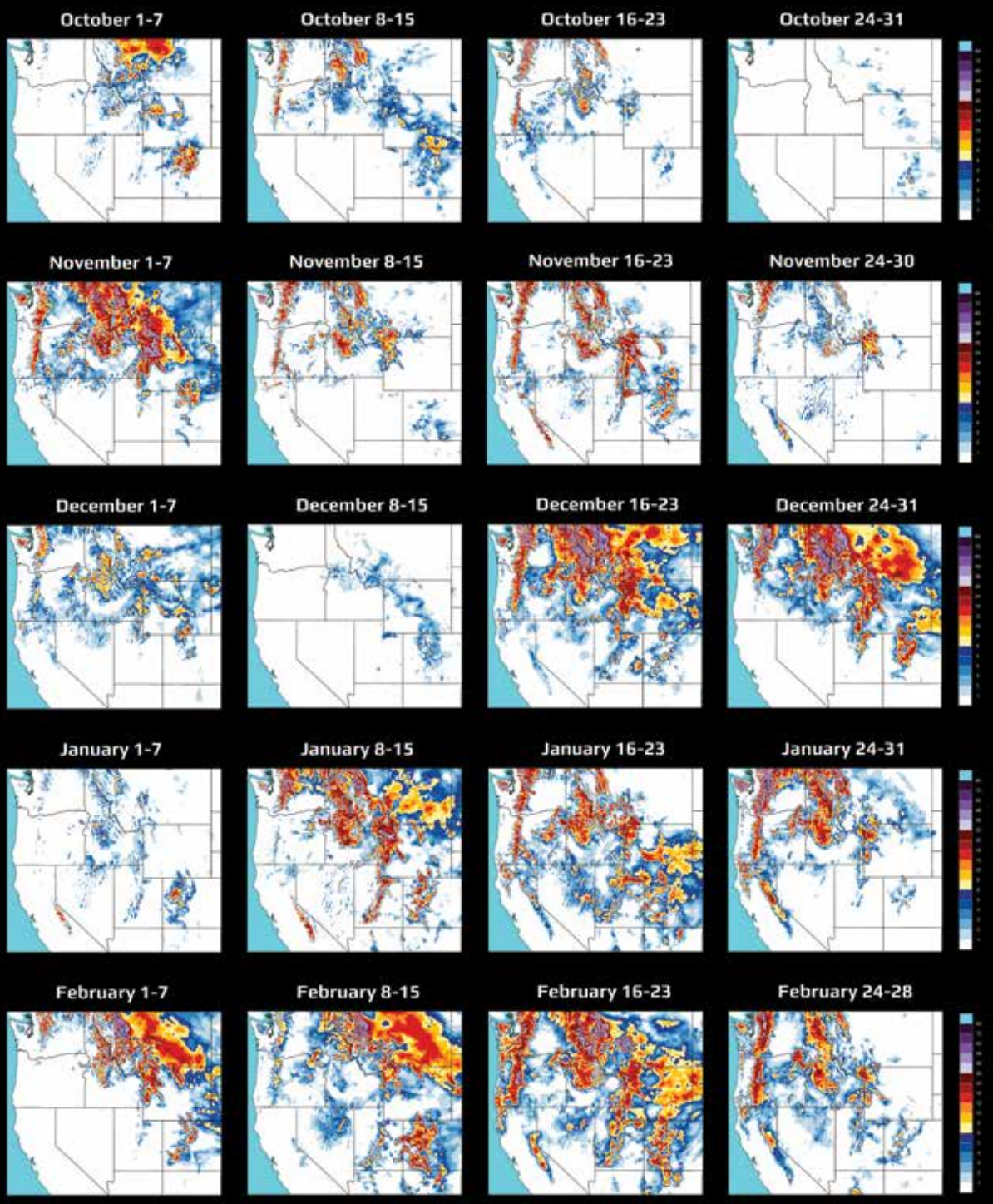
LAYER
LAYER
LAYER



sun valley

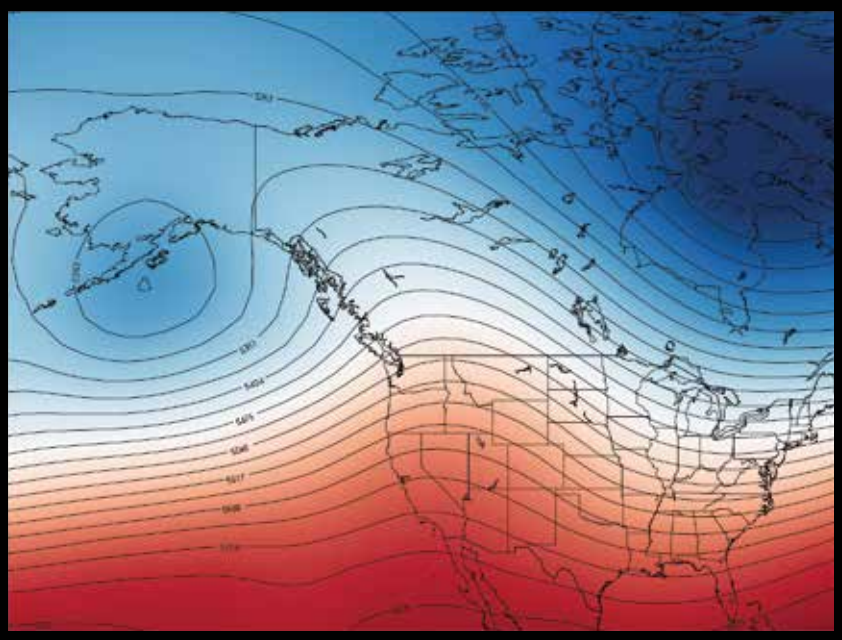
*Photo Chris Cullaz*

This sequence displays total snowfall in inches by week for the western United States.



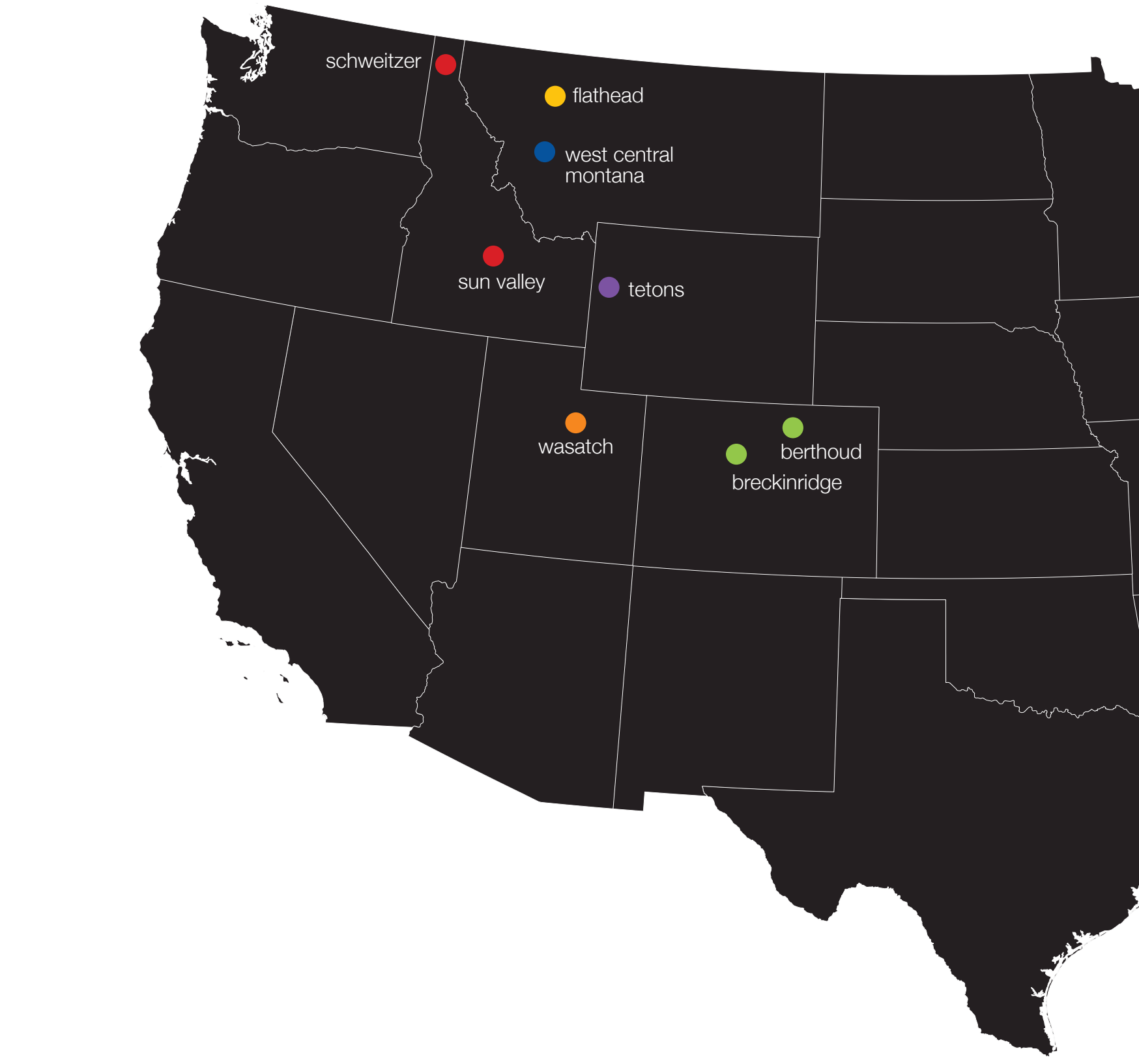

# Weather patterns that created a drought layer: DDL of 2017–18

Average 500mb height over North America during December 2017. A persistent ridge of high pressure along the West Coast led to abnormally-dry conditions for the Rocky Mountains.



By Nick Barlow

**This winter's storm track over North America** depended largely on the placement and amplitude of a ridge of high pressure over the western United States. During December, we saw the ridge axis centered along the West Coast, extending well north into mainland Alaska. The placement of this "blocking" feature is largely responsible for December snowfall patterns and the December Drought Layer, or DDL formation, throughout the western United States.




Persistent, large-scale ridging in the northeast Pacific is consistent with cold-phase ENSO years (La Niña). The Climate Prediction Center (CPC) declared weak La Niña conditions in October, which continued throughout the winter period. This winter's above-average snowfall in the Washington Cascades and Northern Rockies is arguably consistent with typical La Niña snowfall patterns. This was a very unusual year, perhaps 1 in 30, so even though we saw some elements that are common in La Niña years, is there more going on than just La Niña?

As the earth continues to warm above the long-term average, the poles are warming faster than the lower latitudes. Known as Arctic Amplification, this process may have a profound effect on the global waveguide and resulting storm track. Unusually warm conditions near the poles reduce the meridional (north to south) temperature gradient, weakening the strength of the polar jet stream. With less cold air moving south, the eventual result was a highly-persistent storm track that lasted for much of December 2017, especially further south beneath the ridge. Extratropical cyclones (low-pressure storms) feed off the division of warm and cold air. With the weakening of these thermal boundaries, we end up with broader, flatter waves in the atmosphere. These larger waves move at a very slow speed, or even appear to get "stuck," as did the high pressure ridge evident in the weather map from December 8–17.

However, we should be careful about confusing weather with climate—single seasons vs. long-term averages. Attributing this winter's snowfall pattern to a single global process, teleconnection, or large-scale change in climate is dangerous. The global weather pattern is a highly complex system. ▲

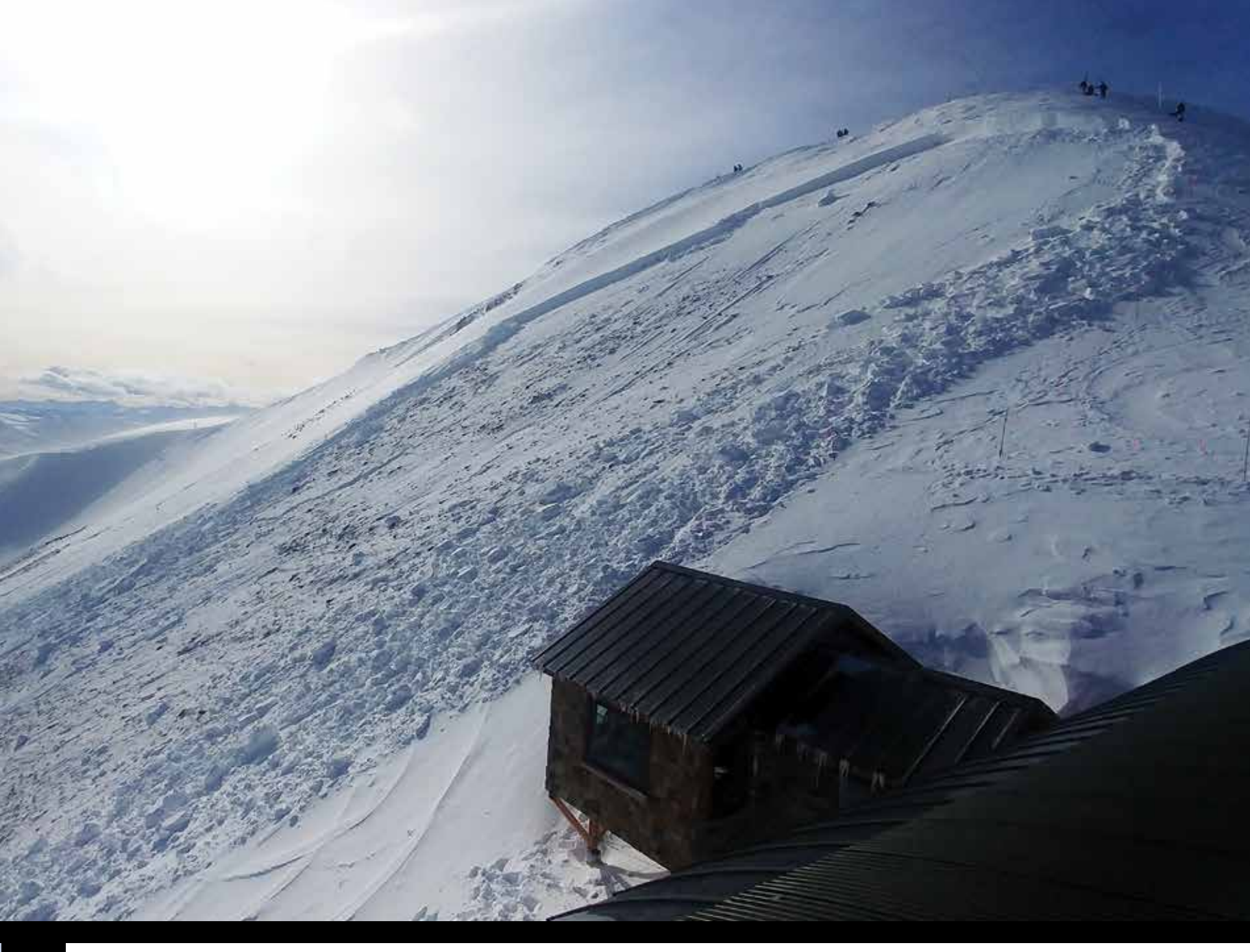
**Nick Barlow** is a Backcountry Avalanche Forecaster for the Colorado Avalanche Information Center (CAIC) in Boulder. Past professional endeavors include guiding heliskiing in Haines, AK, and managing snow safety for Powder Addiction Snowcats near Jones Pass, CO. He holds degrees in both English and Meteorology. In the summer, Nick works as a private-sector meteorologist, monitoring thunderstorms and urban drainage.

# colorado



This was a natural avalanche. Current Creek, Berthoud Pass. This avalanche ran on a 4F depth hoar layer, which sits above a denser layer of DH/ ice forms at the ground. The layer formed after snows in October & November and then we went dry.

We started seeing the first large to very large avalanches breaking near the ground around the beginning of February. We eventually added a Deep Persistent-slab avalanche problem to these zones on 2/13.



# Peak 8 Afternoon Update

**2/18/18**
**Forecaster: Sam Simonds**

### Pertinent Weather Obs:

- Broken Skies, 15°F, W wind 25-30 mph.
- RH dropped to 73% yesterday, back up to 92% by 5AM today.
- 1.5° C/dm near surface temperature gradient this morning.
- Ideal transport speeds overnight with narrow deviations.
- No new snow, warming trend.

### Pertinent Snowpack Obs:

- Deep persistent-slab activated in Imperial Bowl.
- Pencil hard layer underneath the new wind load.
- Cracking 40-60cm down to the pencil hard layer with large shots on Peak 7.

### Observed Avalanche Problems:

- Forecasted: sm to lg wind slab likely on E-SE aspects above and near tree line; sm cornice possible on NE-E-SE aspects above tree line; lg persistent-slab unlikely on N-E-SE aspects above and near tree line.
- Calibrated: lg deep persistent-slab possible on E aspect above tree line with a small shot.

The big result from today is Imperial Bowl, which slid to ground with a 3 lb. shot. See above details.

The last time Imperial slid to ground was 1/4/14. On that day, Imperial slid HS R4D3, 8' crown max 5' crown avg, 300' wide, 850' vertical, to ground on depth hoar.

I also remember Imperial sliding to ground at least 6' deep in 2011, around Feb. 4th, but I couldn't find that data in the avalanche database.

These are deep persistent-slab avalanches. Today's was triggered with a small shot in a very thick part of the snowpack—about 5' deep. Usually deep persistent slides are triggered in a thinner trigger point. Somehow the shot was able to penetrate a pencil-hard layer mid-pack that is about 2' thick. The depth hoar at the bottom of the snowpack was thick enough to overcome irregularities on the ground. The debris ran down to the lake exit. Imperial was shot in a similar location yesterday.

| Path | Type | Size R | Size D | Crown max | Mean depth | Width | Vertical | Elev (feet) | Aspect | Slope | Bed surface | Weakness | Trigger |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Imperial | HS | 3 | 3 | 5.0 | 3.0 | 200 | 600 | 12,970 | E | 34 | G | DF | AE |

wasatch

# Forecasting Issues with Early Season Weak Layers

By Greg Gagne

**Laying the foundation:** Early autumn storms left a shallow layer of facets and depth hoar at upper-elevation northerly aspects in the central and northern Wasatch, and the Utah Avalanche Center (UAC) forecasters were silently holding a "Pray for Rain" party which we hoped would wash away the junk at the ground. Didn't work. A 50cm storm the weekend before Thanksgiving held promise for a start to winter, but the subsequent 15 days only added a few layers of rain and MF crusts, creating facet/crusts combos that further complicated the structure of the snowpack. An early December storm then delivered 20-40cm (with over an 1" of SWE), but the Thanksgiving crusts had enough strength to support the additional loading, and only minor avalanche activity within the storm snow was reported. HS in the upper elevations of the Cottonwoods finally reached 75cm with this storm, although we saw lesser amounts in traditionally thinner snowpack areas such as the Park City ridgeline.

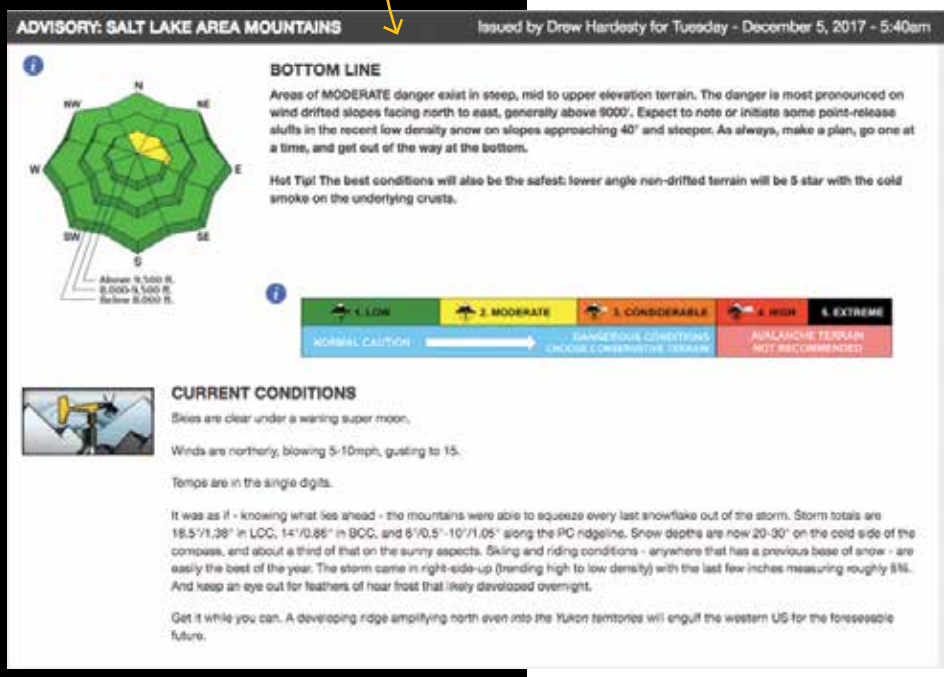
In his 12/5 forecast, Drew Hardesty sagely advised "Get it while you can. A developing ridge even into the Yukon Territory will engulf the western US for the foreseeable future." Fifteen days of cold high pressure followed, and the facet-festival is on. We weren't creating just a DDL (December drought layer), it was a super-sized NDDL on a burly Thanksgiving crust/bed surface.

**Loading a weak base:** A small series of storms after the winter solstice deposited 45-60cm of snow, accompanied by a few wind events, causing the UAC to issue an avalanche warning on Christmas morning. Widespread natural and remotely triggered slides with many close calls, including several patrollers caught and carried, as well as four partial burials in the Ogden-area mountains, filled the avalanche-event list, but fortunately there were no significant injuries. Although much of the activity was near the ground, the Thanksgiving crusts provided enough support to keep the basal weaknesses intact. Riders began to enter steeper terrain as the New Year approached, bringing yet another close call for a guided group in the Alta backcountry, when a large slab failed on the early December faceted layer above Thanksgiving crusts.

**Avalanche cycles ebb and flow:** By early January, the hazard was back to Low as 11 days of high pressure followed the Christmas storm. Storms during the week of January 8 delivered between 1.5" to 3" of water, swinging us back to High as widespread natural and remotely triggered slides failed in faceted snow. The storm track then retreated to the north, but persistent-slab avalanching continued, sending a few folks for significant rides, but fortunately there were no serious injuries. The hazard slowly drifted from High to Considerable down to Moderate. Another inch-plus of water the weekend of January 20–21 bumped us back to the usual round of remotely triggered persistent-slabs, punctuated by a very close call in the Silver Fork Meadow Chutes by a very experienced party. (see UAC drone photo from the accident investigation)

**Deep-persistent-slab gets warm and goes dormant:** Early February brought warm temperatures which began to strengthen the snowpack, especially in deeper snowpack zones such as the upper Cottonwoods. At the UAC, we dropped the danger rose to Low on February 8 for the first time in five weeks.

**Some forecasting considerations:** During the several avalanche cycles where the persistent-slab problem came back to life with new loads, the UAC was challenged with messaging the problem to our powder-starved readers. As we maintained a Moderate or Considerable hazard for the persistent-slab problem, often as steep lines were beginning to get skied, language such as "Scary Moderate" and "Low Probability/High Consequence" frequently appeared in daily advisories. We were also influenced by Jason Konigsberg's work that asks, "How long after a snowfall can you trigger persistent-slab avalanches?" *(Answer: about a week. Check TAR 36.3.)* We also struggled with migrating from persistent-slab to deep slab as an avalanche problem as a deeper slab developed. (We chose to remain with persistent-slab to keep the message simple.) Forecast centers—especially those in the intercontinental beltway—often deal with these issues each season. We're working on it. Despite several close calls, we do feel overall that our users did heed the consistent, day-to-day message that avoiding terrain is the only way to "manage" the persistent-slab problem. Patience and discipline are hard to maintain in the face of good powder skiing. ▲


ADVISORY: SALT LAKE AREA MOUNTAINS

Issued by Drew Hardesty for Tuesday - December 5, 2017 - 5:40am

BOTTOM LINE

Areas of MODERATE danger exist in steep, mid to upper elevation terrain. The danger is most pronounced on wind drifted slopes facing north to east, generally above 9000'. Expect to note or initiate some point-release slufts in the recent low density snow on slopes approaching 40° and steeper. As always, make a plan, go one at a time, and get out of the way at the bottom.

Hot Tip! The best conditions will also be the safest: lower angle non-drifted terrain will be 5 star with the cold smoke on the underlying crusts.

1. LOW | 2. MODERATE | 3. CONSIDERABLE | 4. HIGH | 5. EXTREME

NORMAL CAUTION → DANGEROUS CONDITIONS, CHOOSE CONSERVATIVE TERRAIN → AVALANCHE TERRAIN NOT RECOMMENDED

CURRENT CONDITIONS

Skies are clear under a waning super moon.

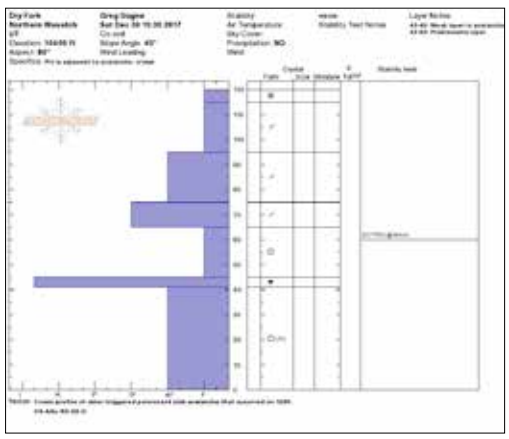
Winds are northerly, blowing 5-10mph, gusting to 15.

Temps are in the single digits.

It was as if - knowing what lies ahead - the mountains were able to squeeze every last snowflake out of the storm. Storm totals are 18.5"/1.38" in LCC, 14"/0.86" in BCC, and 8"/0.5"-10"/1.05" along the PC ridgeline. Snow depths are now 20-30" on the cold side of the compass, and about a third of that on the sunny aspects. Skiing and riding conditions - anywhere that has a previous base of snow - are easily the best of the year. The storm came in right-side-up (trending high to low density) with the last few inches measuring roughly 8%. And keep an eye out for feathers of hoar frost that likely developed overnight.

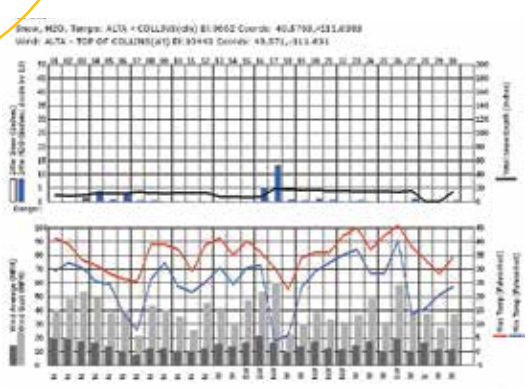
Get it while you can. A developing ridge amplifying north even into the Yukon territories will engulf the western US for the foreseeable future.

**Greg Gagne** has been working for the UAC as a field observer and avalanche educator since 1995. He began his current role as part-time forecaster in 2016. He is a continuing education student at the Brett Kobernik School of Garage Science for Snow Nerds.

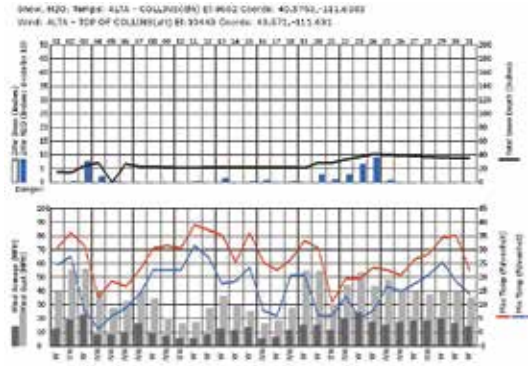


This photo was taken from drone footage of UAC Forecaster Trent Meisenheimer and UAC Observer Mark White doing a crown profile of the Meadow Chutes slide.

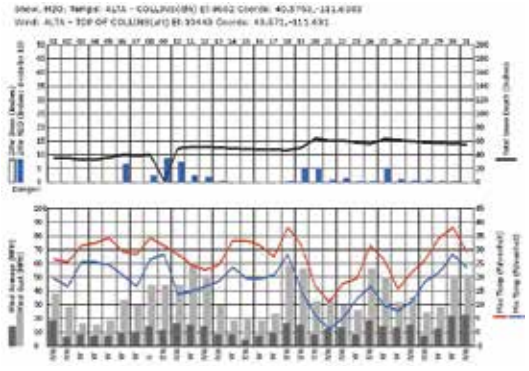
November, 2017

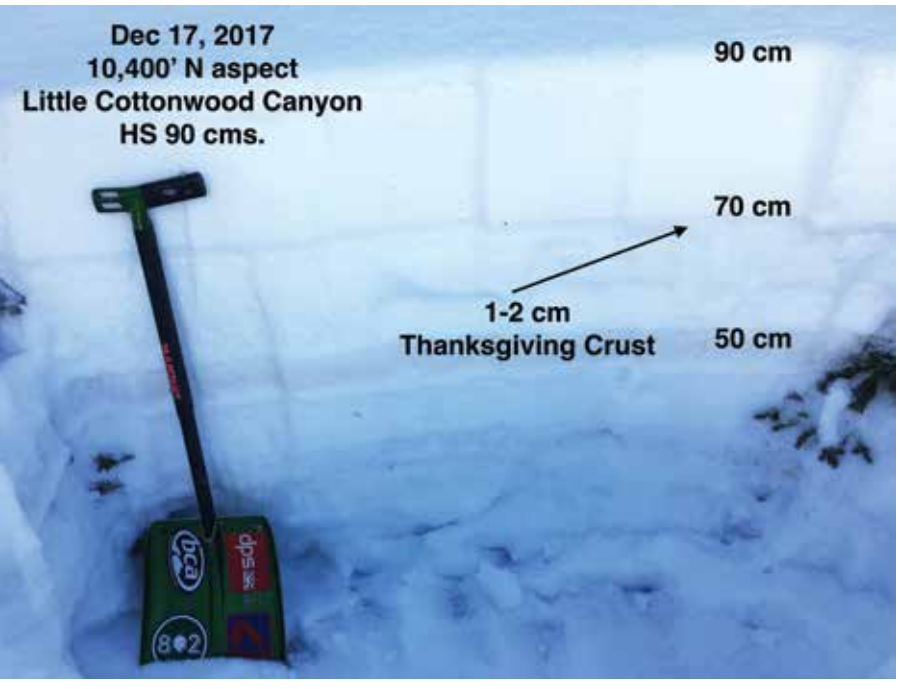


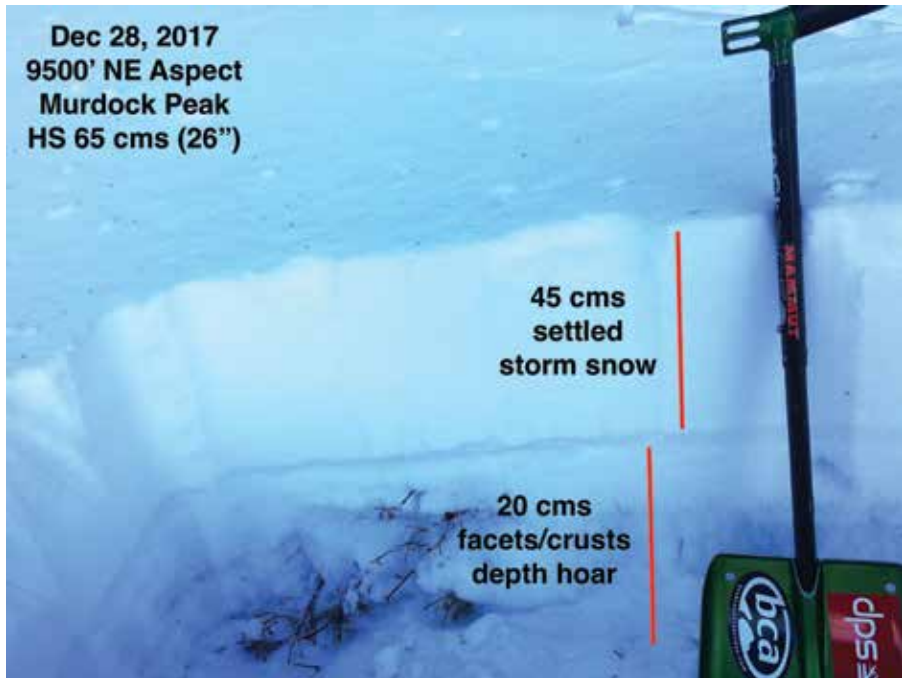
December, 2017



January, 2018





This is a skier-triggered slide in West Monitor; the fifth skier on the slope triggered it mid-slope in a thin spot, was caught and carried a small distance but ended up ok. The avalanche took out three storms worth of snow. *Photo Mark White*

An avalanche in the Room of Doom in Mineral Fork; this was a natural that basically took out the whole season's snowpack. *Photo Mark White*

Stress cracks from an intentionally triggered slide on Reynolds Peak; this avalanche also went on faceted snow at the ground. *Photo Mark White*

# The Meaning of Persistence

By Sean Zimmerman-Wall

Persistent slabs in the forest where a majority of our problem layers were located. *Photo Sean Zimmerman-Wall*

**The slab fractures** at her tails as she puts the third ski cut on the slope, and a tense "whoo" escapes her lips as she carries speed over to our position. A three-foot crown is all that remains in the small pocket, but the slide takes out a larger piece just below, continuing downslope for another several hundred vertical feet through old-growth timber and over rock bands. Our senses heightened, we decide to place an air blast on an adjacent snowfield. The shot pries out a similar depth slab, this time closer to 100-feet wide. It rushes through the forest, piling up debris six-feet high on massive pine trunks. We've been reluctant to open this terrain this season due to low coverage and a persistent faceted layer from the early December drought conditions. As a consequence, this mid-elevation, northwest-facing slope has not received the benefits of skier compaction that some of the surrounding terrain enjoyed. Moving tentatively down the bed surface we survey the destruction these slabs paid out. Nearly all the snow is scrubbed down to the facets sitting about a foot off the ground. Our triggered slides paired with a previous avalanche caused by a 105mm Howitzer round expertly placed by our snow-safety team has cleaned out this entire swath of terrain. 1,500 vertical feet of relief finds the runout of the debris crossing one of our main ski runs below. It's 8:45 am, and our work on this route is done. Now it's on to the next drainage.

Similar results are found across un-skied terrain within the resort, and we are now turning our attention to more stubborn areas that we know harbor the same weak layer. For early January, these aren't necessarily abnormal conditions, but in my short career, I've never seen such connectivity across terrain. A cagey veteran told me not two weeks ago that this season has made him reassess his preconceived notions, and he's gone back to the mentality of a first-year patroller: "bomb everything, trust nothing."

My team's next mission is to split up across the mid-track of a large east-facing bowl and hunt for the weaknesses now buried under a stout skier/wind slab in previously opened terrain. From the ridge, we wait on a team working another portion of the bowl. From our position, we have a bird's-eye view of their shot placement just beneath a large rock band mid-slope. The air blast sends shockwaves through the terrain, and a loose dry avalanche cascades through the cliffs and onto the slope below. At that instant, a crack shoots across the bowl, and a hard slab eases out and begins to travel downhill. Hundreds of feet wide and over three-feet deep, it carries the rope line dividing the bowl with it. I radio to the team below that this slide is coming toward their position, and they vacate the area like wild horses running from a lightning bolt. Witnessing the event leaves us in awe, and we are relieved that everyone is out of harm's way. The toe of the slide crosses yet another main run, and it is a clear reminder that sometimes you find what you are looking for. Our team carries on and places similar air blasts on the remaining portions of the bowl. No results. A curious problem indeed.

Upon investigation of the crown later in the day, we find several old shot holes in the snow above the failure plane. This slide stepped down from the December facets into a preserved faceted graupel layer from mid-November. For what it's worth, this low snow year has given us a lesson in the meaning of persistence, and we will catalogue this info into our brains for seasons to come. Perhaps we can even turn it into knowledge to pass onto the younger generation one day as we become the cagey veterans ourselves. ▲

**Sean Zimmerman-Wall** is at the tail end of his ninth season as a Snowbird ski patroller. In addition to searching for persistent-slabs, he coordinates the resort's avalanche education program and works as a backcountry ski guide in the US and Argentina. He is currently serving as the At-Large Pro Trustee for A3.

wasatch

Top: Ski patrol checking out the crown of the explosive-triggered hard slab.

Bottom: Large persistent hard slab in the middle cirque. *Photos Sean Zimmerman-Wall*

# The Ebb and Flow of the DDL in the Tetons

By Jake Urban

**An early start to winter…**

Early season snowfall in the Tetons made for some surprisingly good turns in September on north-facing terrain above 9,000'. The follow-up storms in October and November made you believe it was going to be another deep- and persistent-problem-free Jackson Hole winter. As of December 6th, we had received 139" of seasonal snow…and then the December drought began…seven days of facet-farming weather.

**The beginning of a problem…**

On December 14, 2017, I went to a burial. It was on this day that the December Drought Layer, or the DDL as we have affectionately termed it, was buried and unfortunately not laid to rest. Rather, it came to haunt us for at least the next few months. Jamie Weeks' statement in mid-January summed it up succinctly: "I'll trust the DDL when it's in the Snake River."


The beginnings of a persistent problem. A several day storm buries the December Drought Layer and the overriding slab is stiff enough to begin communicating the failures in Extended Column Tests.

**The "weighting" game…**

Once buried, we didn't have to "weight" long to see results. By Christmas we had already been receiving presents from the loading of our PWL…many R2-D2 avalanches. By the time we were celebrating the New Year, D3s had already arrived.

A slowdown began after the New Year, suggesting that maybe the DDL was beginning to show some strength. By the end of the second week of January, a new load of moisture was served up and our dreams of stability were crushed. Another round of destructive and unsurvivable avalanches was to follow…this time with even more destructive capability as locomotives were no longer safe in avalanche terrain. Which ushered in a new and more destructive problem: the Deep Persistent Slab. The DDL was buried five-feet deep and well preserved.

Mid-January gave us five days with no reported activity between the 17th and 22nd and a widespread surface-hoar event. Had the dragon left or simply gone to sleep? Unfortunately, it was just a little "deeper" asleep than during the weeks prior. While it might have been a little more difficult to wake up, it still had the same attitude once it reared its head: large and destructive. This was confirmed with another new storm load. Just 0.7" of SWE on January 23 was enough to awaken the dragon and bury a wide spread surface-hoar event. The last few days of January added nearly another 3" of SWE and treated us to another cycle of mid-range D3 monsters that arrived in its wake.

**Persistently reminded…**

The beginning of February brought in a healthy dose of moisture: nearly 3.5" of SWE in the first six days. This added enough weight to activate the 1/23 surface hoar, which was stepping down and reactivating our beloved DDL.

By now it was clear that the deep-persistent slab was doing just that, being a persistent avalanche problem. Additionally, it was true to itself. Waxing with additional load, waning with time, although occasionally rearing its head with little warning or reason to its frequency or location. Moving in avalanche terrain was like playing Whack-A-Mole…except *you're* the mole.

Now at the end of February as I write this piece, another round of heavy precipitation is being served up in the Tetons. In-storm instabilities are certain but how it affects the DDL is yet to be seen. While it is sure to be buried deeper, the fickle nature of the deep slab continues as it took the life of a snowmobiler just a few days ago.

Despite the feedback from the load post storm, I'll stick to the same risk-management plan I've been using since the DDL was buried: appropriate terrain choices. And every time I second-guess the routine of "entrenchment," I will remember what I wrote in my field book after I heard it: "I will trust the DDL when it is in the Snake River." Possibly the best interpretation of a field observation ever recorded. ▲

**Jake Urban** is a rescuer, educator, and student of the mountains. He owns and operates the Jackson Hole Outdoor Leadership Institute, is an Adjunct Faculty Member at Lyndon State and Central Wyoming Colleges, and is a member of Teton County SAR. He unsuccessfully tries to avoid all of those responsibilities by running, climbing, and skiing in the Tetons as often as possible.

This avalanche was observed on January 15, 2018. It is thought to have released in the morning hours of January 14, shortly after a big loading cycle. The crown ranged from 30cm to 180cm. After releasing from the start zone it propagated 300-400m under a cliff band running full track to the valley floor some 700m below.

Above: This naturally occurring slide was observed on January 24 and is estimated to have released earlier that morning. Strong southerly winds were observed throughout the morning and afternoon. It is believed the wind cross-loaded this feature, loading the DDL on the northern aspect to failure, and causing the crown to propagate around to the eastern aspect.

Below: The DDL got loaded by wind slab early February in a run variably called Skeeter's, Bank Shot, or Igg Piggy in Mail Cabin, Teton Pass. *Photo Chris Davis*

Above: The avalanche observed in the Bear Claw is thought to have released the morning of February 4, 2018. The crown on this avalanche ranged from 30cm to 150cm and propagated across four separate couloirs through mature trees on two different aspects. Start zones were mid-track in one of the couloirs on a 30-degree slope.

Below: One of the first set of miscreants on the DDL: Big Bluff, Platforms, Garnet Canyon, North Aspect, Grand Teton National Park, SS-N/AC-D3-I. Observed; 31 December 2017.
Every slope, all aspects, from Platforms to mouth of Garnet came down to the creek, the lower ones various times around Christmas, the higher ones pre-New Years Eve wind. *Photo Greg Collins*

*Photo Chris Davis*

My group remote triggered this size 3 avalanche from a low-angle ridge on a day when perfect route finding was required. We were lucky to be just perfect enough as moving our location another 2-3 meters would have put us on the slope that failed. While this incident helped confirm that our ridge was in fact lower risk terrain, our proximity to the slide was way too close for comfort, creating a near-miss situation. I am left wondering just how many days over a career one can manage terrain perfectly in the face of a complex avalanche problem.

The debrief is everything. Once my guests and I returned to the base area, we headed to the Trap and debriefed over beers. We gave space for each person to say what they felt during the event, how they felt now, and where we could have been better. For those of us who spend so much time in and around avalanche terrain, the only way to increase our chances of survival is by decreasing exposure, no matter what the danger is. Hopefully over time, near misses become fewer and farther away from the direct hit. Through debriefing these events we can make our best practices even better, but, as you say (in an email exchange between Scott and Lynne Wolfe), we have to "wryly acknowledge our biases and budget for them in the formula for the day."

*—Scott Palmer*

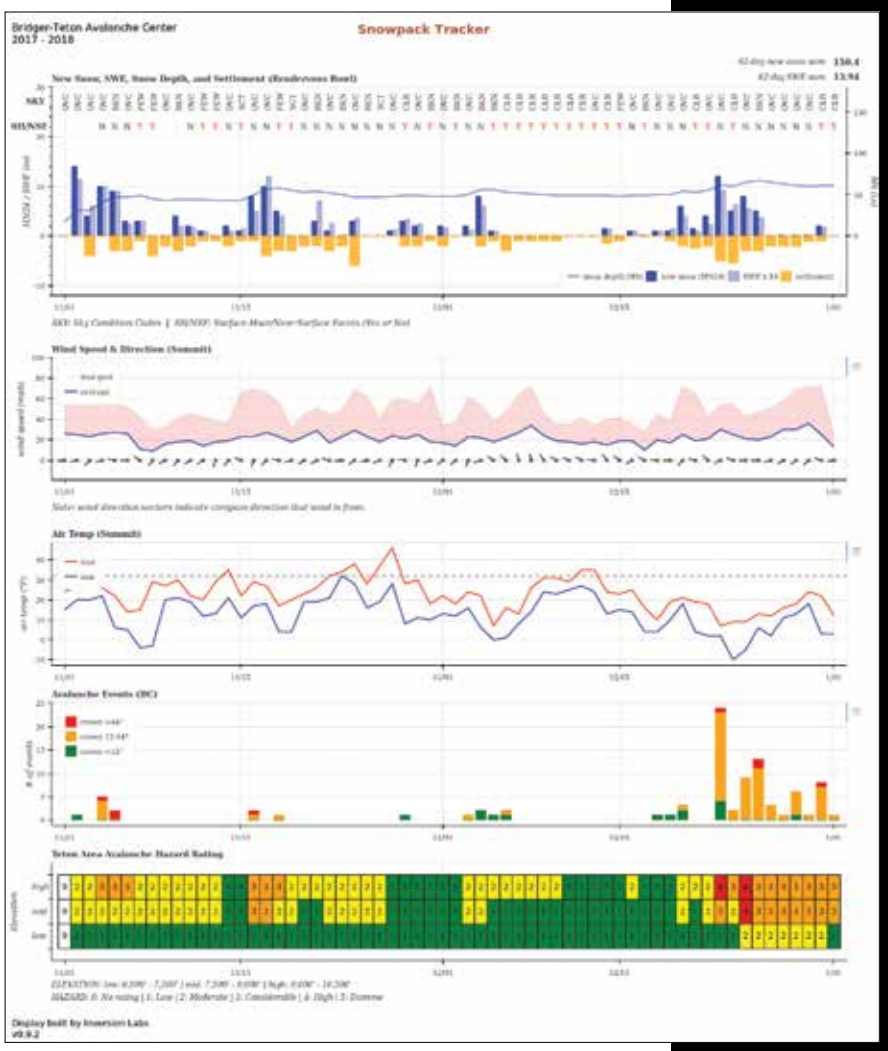
Grand Targhee Wyoming Backcountry: South Bowl January 13, 2018
Phil Edmonds (Grand Targhee Assistant Ski Patrol Director) checking out the crown. *Photo Lindsey Fell*

# Season progression for the Bridger-Teton forecast area

By Bob Comey, Figures by Inversion Labs

**The season started** early. Twelve-day storm cycle from Sept. 14–26 with 2' of snow and 3.5" of SWE. This snow remained for the rest of the season at upper elevations, northerly aspects.

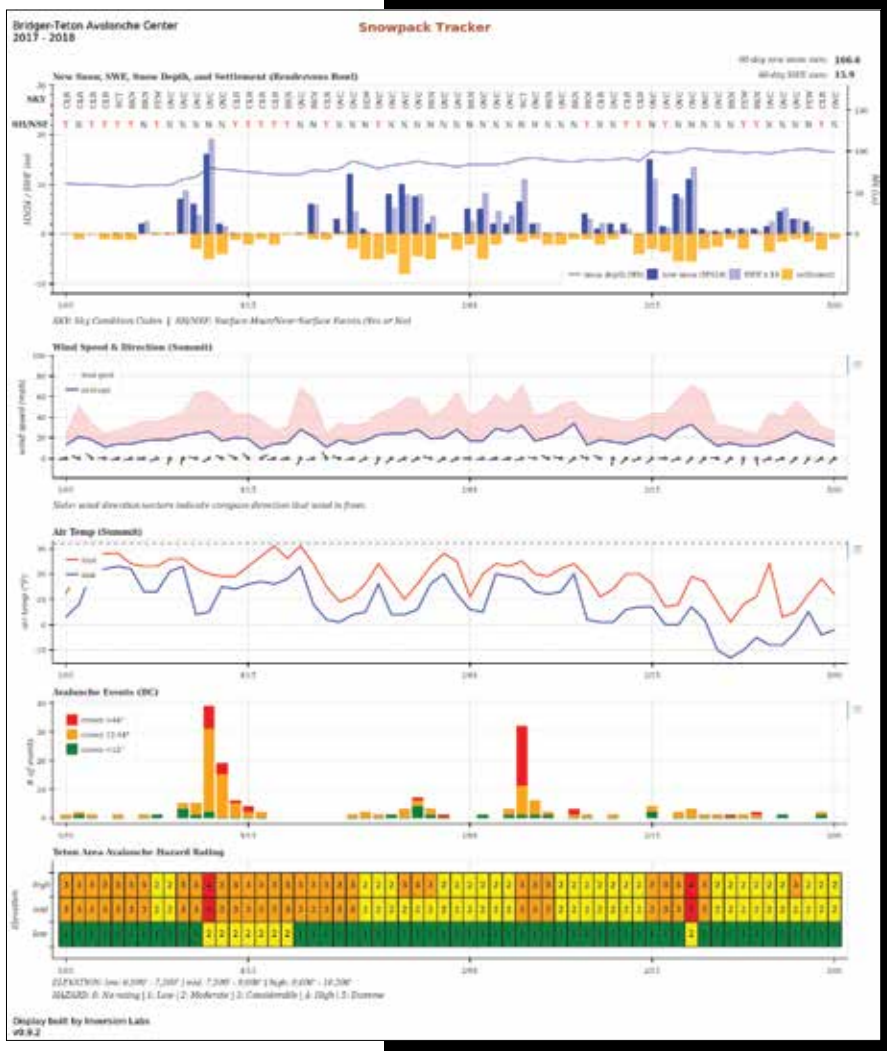
- From Sept. 14 to Dec. 7, the Teton area received 165" of snow with 17" of SWE (precipitation preceding the DDL).
- First significant deep slab occurred on Nov. 5 in Garnet Canyon. This occurred before the DDL was formed, but was a huge early season event (estimated crown depth, 120").
- Bed surface for the DDL formed on Nov. 24 with warm temperatures and rain to 11,000 feet.
- New snow was deposited on this bed surface between Nov. 25 and Dec. 7 (11" with 1.22" SWE).
- The DDL persistent weak layer formed during Dec. 7–16 when new snow overlying the thick November rain crust faceted during a dry period with cold, clear nights.




Development of the Deep Persistent-slab problem in the BTAC bulletin (as of early March, 2018):

12/16 to 12/22—Wind Slab Problem
12/23 to 1/12—Persistent-slab Problem
1/13 through early March—Deep Persistent-slab Problem

- Deep-slab avalanches cycles occurred in January and February. The most prominent was during the evening hours on Feb 4 through dawn on Feb 5. Many very large deep-slab events occurred this night.
- 2 snowmobile fatalities were confirmed on the DDL persistent weak layer:
- Dec 29, Commissary Ridge, Wyoming Range
- Feb 20, Sheep Creek Mountain, Snake River Range (Palisades)
- As of March 9, the Deep Persistent-slab problem remains. From Dec 16 to March 7, the Teton area has received approximately 225" of new snow with 22.5" of SWE.
- There is significant potential for the DDL to be re-activated this spring with deep wet-slab events.




*Note on limitations of avalanche events displayed on Snowpack Tracker:*

Many, if not most, avalanche events occur during storm periods and are not observed and therefore are not displayed by Snowpack Tracker. In addition, the dates of occurrence of many observed avalanche events are uncertain and estimated.

These very important limitations are essential with respect to the interpretation of avalanche-event data. Users of this tool cannot over-interpret the avalanche activity or lack of activity that is displayed. The displayed avalanche events on Snowpack Tracker often do not correspond well with what has occurred in the real world. ▲

# 09 sun valley

Top & center: Two feet of snow (2" of SWE) fell at this location during two separate storms over the span of a week. One day after the second storm had ended and one month after burying the (12/19) weak layer, SAC forecasters dropped large cornices on a north-facing slope in the Sawtooth Mountains. Several large avalanches failed 1.5-3' deep on the (12/19) weak layer. A sympathetic persistent-slab released 500' away on the same ridge (pictured).

Bottom: About 20" of snow (1.7" of SWE) fell in this location in the first 10 days after burying the (12/19) weak layer. Strong wind whipped new snow into slabs at upper elevations. This slide was one of dozens of recent large slab avalanches observed in the Fishhook Valley of the Sawtooth Mountains. *Photos Ben VandenBos*

Paradise: Sweet North- Don't Think

A powerful storm dropped up to 15" of snow and 1.5" of SWE in less than 24 hours to prompt the SAC's first Avalanche Warning of the season on January 12. This load initiated a widespread avalanche cycle depicted in these images from the western Smoky Mountains. Storm totals here tend to be significantly greater than in the Wood River Valley (even compared to Galena Pass up north).
*Photos courtesy Sun Valley Heli Ski*

Pinyon: Hoochikoo- Light My Fuse

Baker Divide, Baker Creek headwaters

Paradise: Costly Sunglasses

Dash Longe about to get a wakeup call, Chatter Creek, B.C.
Photo: Grant Gunderson



**Right:** Less than a foot of snow and subtle wind effect was enough to set off these slides near Galena Summit. The (12/19) weak layer would plague the snowpack and our advisories for the next two months.

**Below:** This small persistent-slab avalanche failed four days after burying the (12/19) weak layer. In this location (12/19) presented as facets above a melt-freeze crust.
*Photos Matt Weiland*

sun valley

# BSH as DDL

By Logan King

**Across West Central** Montana we had a lull in precipitation that ran from late November through mid-December. A substantial crust formed around Thanksgiving. Diurnal recrystallization and surface-hoar growth marked the extended drought that followed the crust formation. We anxiously watched as surface hoar developed most nights and broke down most days, hoping that any new load would fall before surface-hoar growth resumed.

Mid-December brought the return of snow and the start of our regular advisories. The first big system to impact the region, unfortunately, fell on the layer of surface hoar and Thanksgiving crust which resulted in the first avalanche warning of the season. The now-buried surface hoar (BSH) was reactive but to a lesser extent than anticipated. As the snow began to settle, the region picked up the odd inch here and there for a week, further burying the BSH.

Following Christmas, West Central Montana was the benefactor of a Pineapple Express system. The warm and wet pattern resulted in unsettled conditions again. A deposition of heavy wet snow fell on top of the cold snow that had slowly accumulated over Christmas. The storm resulted in another warning on December 29 and 30 as 1-2.5 inches of SWE was added to the snowpack each day. After the warnings, the danger remained high as the BSH and Thanksgiving crust were suspect even if they were not overly reactive. The instability at the onset of the warning was a storm slab from the now upside-down structure, and the BSH/Thanksgiving crust was dormant during the earlier stages of the storm.

As the storm diminished, the BSH and Thanksgiving crust was nearly a meter deep. What was interesting was after the storm-slab activity dropped off, areas where wind slabs had formed became reactive. The two to three days following the storm resulted in widespread wind-slab activity that consistently broke down to the BSH and Thanksgiving crust. Large nearly full-depth avalanches failed naturally and from remote triggers.

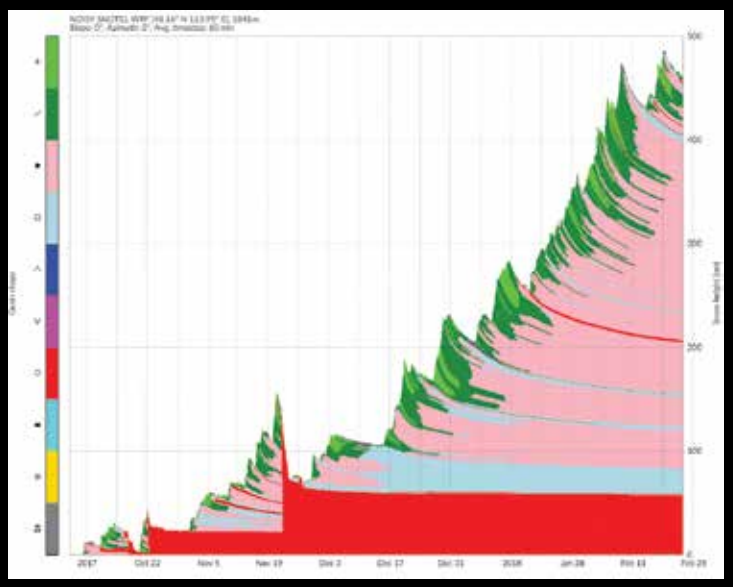

There are three crowns. Left to right: AMr D3 R3 O, AMrD4 R4 O, NSy D3 R3 0. The avalanches occurred about two to three days after the storm and were down to the DDL. *Photo Logan King*

The unusual delay in the reactivity of the BSH and Thanksgiving crust, along with the progression of avalanche problems, was remarkably uncharacteristic of the region. Large natural avalanches were occurring in areas that don't regularly have activity and well after the snowpack had the time to adjust to the new load. We had been leery of the BSH and Thanksgiving crust for two weeks and had two massive storms impact the area. The persistent weak layers were finally deep in the snowpack, and we were left wondering why it hadn't been reactive yet and would it ever be? A few days after the storm had ended it suddenly awoke without any clear indicator as to why. After many discussions around the region, the consensus was that an avalanche cycle of that magnitude paired with the lag after the storm was a first in the area. The working theory is that the stiffer wind slabs and colder temperature were the missing ingredients to activate the BSH and Thanksgiving crust. The lesson learned was that if you don't trust a layer, there is probably a good reason; given time, suspect layers will likely prove themselves to be a problem.

If anyone out there has any further insight into our layer combinations and our conclusions, please send me a note at lking@missoulaavalanche.org. ▲

**Logan King** is a former ski patroller who has been working for the WCMAC for the past seven years and is currently the Lead Specialist. Logan has a BS in Snow Science from Montana State and is currently working on a master's in Applied Meteorology. He resides in Missoula, Montana, where he and his wife are raising a daughter who has inherited her father's passion for wintry landscapes.

# flathead



**Our DDL produced** deep-slab avalanches through early February and resulted in "one of the most challenging snowpacks in recent memory." (That is credited to Erich Peitzsch, not me. This stuff was a cakewalk compared to Colorado.) It started as a facet layer over a stout rain crust (AKA the Thanksgiving crust)—we had a purging rain event to mountain tops on Thanksgiving, followed by low-density new snow that subsequently faceted after two weeks of high pressure. The layer was immediately touchy under its first loading event, which produced the most widespread cycle of the winter with 3" SWE in mid-December. We saw continued activity on the DDL with every storm cycle until February 8. By mid-January, the DDL produced deep-slab avalanches in excess of 10-feet deep and up to D4 in size. The deep-slab activity culminated on February 8, when we saw a significant warm-up at the tail end of an 8" SWE storm. After two weeks of inactivity under smaller, colder storms, we pulled deep slabs off the problem list on February 26.

*—Zach Guy*

**Zach Guy** recently migrated his deep-slab problems from Crested Butte to NW Montana, where he is the director of the Flathead Avalanche Center. He also bought a rain jacket this winter.

TAR asked Zach how deep the slab averaged on top of the DDL:

At wind-sheltered SNOTEL locations, the slab was about 3 to 4 meters deep. We stopped digging in mid-January because our backs were sore. We estimate the resulting avalanche activity during the last cycle was a little smaller than that (2 to 3 meters? Never made it to the crowns, just viewed them from afar). My guess is some of these paths had run already or just had shallower snowpacks from wind effects or whatever reason.

This graph is a snowpack model for February 21, 2018, for Noisy Basin in the Swan Range (our favored snowfall location). You can see the Thanksgiving crust (dark red) and DDL (light blue) at the bottom of the snowpack, and all the subsequent storms. You can see three major peaks ~Dec 20, Dec 30, Jan 13 that all correspond to DDL cycles. The first two cycles went storm slab, then persistent-slab, then to deep slab, and the Feb 8 peak was the final one (so far).

But we reserve the right to relist it when spring thaw arrives or if we get slammed again.

**Top to bottom, left to right:** DDL carnage after the first storm cycle Park. *Photo Adam Clark*

Natural and skier-triggered slides galore! The DDL cycled in widesp under its first storm. December 18, 2017 FAC forecaster Chris Bilbr slab that we kicked off in Crystal Creek, Flathead Range. *Photo Zac*

A D4 that ran to valley bottom off of Mt. Nyack. January 12, 2018. over 10-feet deep.

The DDL evolved toward a deep-slab problem by mid-January. Nat Marion Lake, Flathead Range.

Good Heavens! Mature swaths of forest toppled below Heavens Pe 2018, in Glacier National Park.

e. Glacier National

pread fashion
ey peaks at a
*h Guy*

The crown was

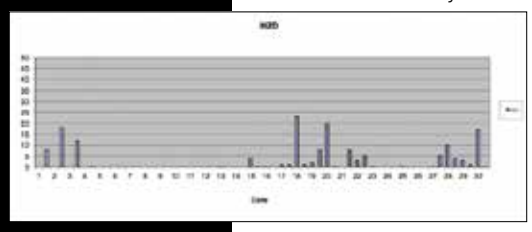
urals above

ak on February 8,

# The December Drought Layer at Whitewater and Kootenay Pass, British Columbia

By Wren McElroy

December 2017 Daily Snowfall



**Deep tap test:** on the December 15 surface hoar north aspect 2025m down 117cm sudden planar results. I've been calling it the sleeping giant. #sleepinggiant

We knew it was there but had to wait for it to wake up, and even now it seems like it is starting to heal... but I don't trust it.

*All photos this page courtesy Wren McElroy*

**Taco chip surface** hoar (see Brad Steele photos) from mid-December was initially buried by 4cm of very low-density snow, then by three different cycles of 20cm snowfall, all with no wind and cold temps. After a significant temperature inversion in the alpine, the slab began to develop and produced two notable avalanches on December 31 and January 4. Deep tap tests and an ECTP 22 dwn 47 on 171215 SH 3-10 above MFcr on January 5 corroborated our observations.

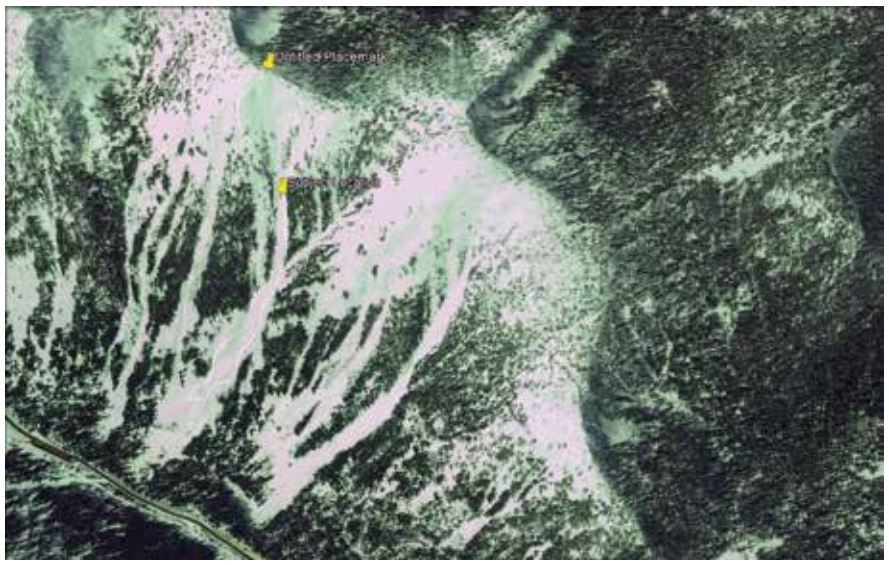
In the January 4 avalanche, a skier accidental size 3 on Evening Ridge caught one skier, requiring his evacuation late into the evening. It was steep terrain and a challenging rescue with significant overhead hazard. A late day rescue and extraction by winch helicopter is credited for saving his life. Side note: he spent four weeks in hospital in Canada and is now in a recovery centre in Switzerland, where he is learning how to walk again after multiple surgeries from bilateral broken femurs.

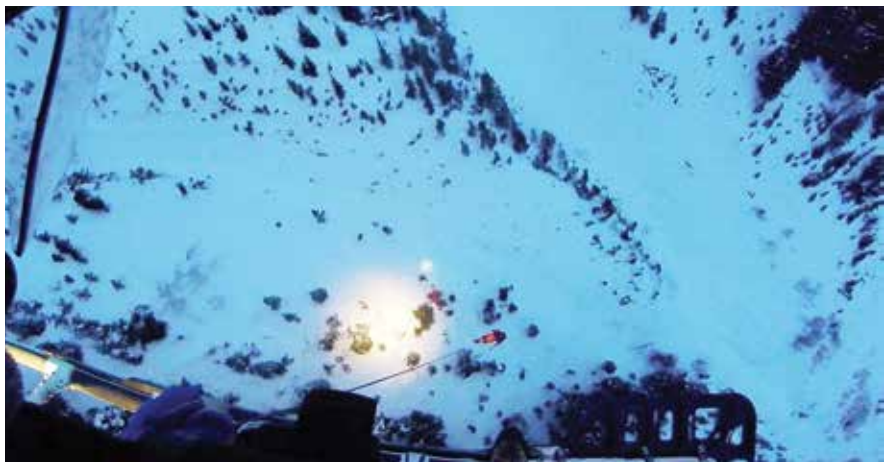
On December 31 there was another incident on the same aspect and elevation (east at 2000m) at Kootenay Pass (one-hour drive from Whitewater).

The subject was recovered pulseless after a 20-minute burial and revived by companions, but taken off life support within the week due to the damage from asphyxiation. The rescue was performed by Nelson SAR and a Kootenay Pass avalanche technician.

Now in March, the December surface hoar is 220 centimeters down and has generally healed, but this sleeping giant may wake up in the spring. ▲

**Wren McElroy** is a Canadian Avalanche Association Level 3 Professional Member and works as an avalanche forecaster at Whitewater Ski Resort and an Industry Training Program Instructor with the CAA.





*All photos this page Brad Steele, www.backcountryskiingcanada.org*

March 16, 2018: Here's a photo of an avalanche I triggered today at the top of Little Superior Buttress. Fresh wind slab was very sensitive to ski cuts. *Photo Mark White*

# A piece of fiction

BY DREW HARDESTY

I was touring up in Mineral Fork of Big Cottonwood yesterday. Never liked it in there—spooky, full of ghosts. Always feel claustrophobic. Know the parable of the scorpion and the frog?

The persistent-slab and I talked for a bit on the uptrack. I found ECTX and XPST-60/90.
*"It's ok, come on into my terrain,"* she said.

*"But I don't trust you, I don't like it."* Indeed the powder looked good in moonlight.

*"No, really,"* she beckoned—*"it's ok, come on in."*

I hesitated. Then dropped in. And the slope shattered like a windowpane. *"But I thought you said…."*

*"Sorry. It's just my nature."*


*Photo Nick Meyers*

THE AVALANCHE REVIEW
PO Box 248
Victor, ID 83455



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A Publication of the
American Avalanche Association

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