38.2
DECEMBER 2019

last snow flake of
winter storm
creates instability

THE AVALANCHE REVIEW

photo Art Burrows

TOOLS FOR THE SEASON

In the above photo you can see only a small portion of a massive D5 avalanche that ran off Garrett Peak above East Snowmass Creek overnight March 14–15, 2019. The full extent of the avalanche broke around two miles wide and ran over 2200 vertical feet to the creek bottom.

In the right photo, this natural slide (HS-N-D3-O) near Stanley, Idaho released in late January during last winter's first significant loading event. The thickest portions of the crown were over 15 feet tall. This avalanche released on a shady slope below Williams Peak in the northern Sawtooths on the same day two skiers self-rescued themselves from full burials 50 miles to the south in the mountains near Ketchum.

photo Tanner Haskins

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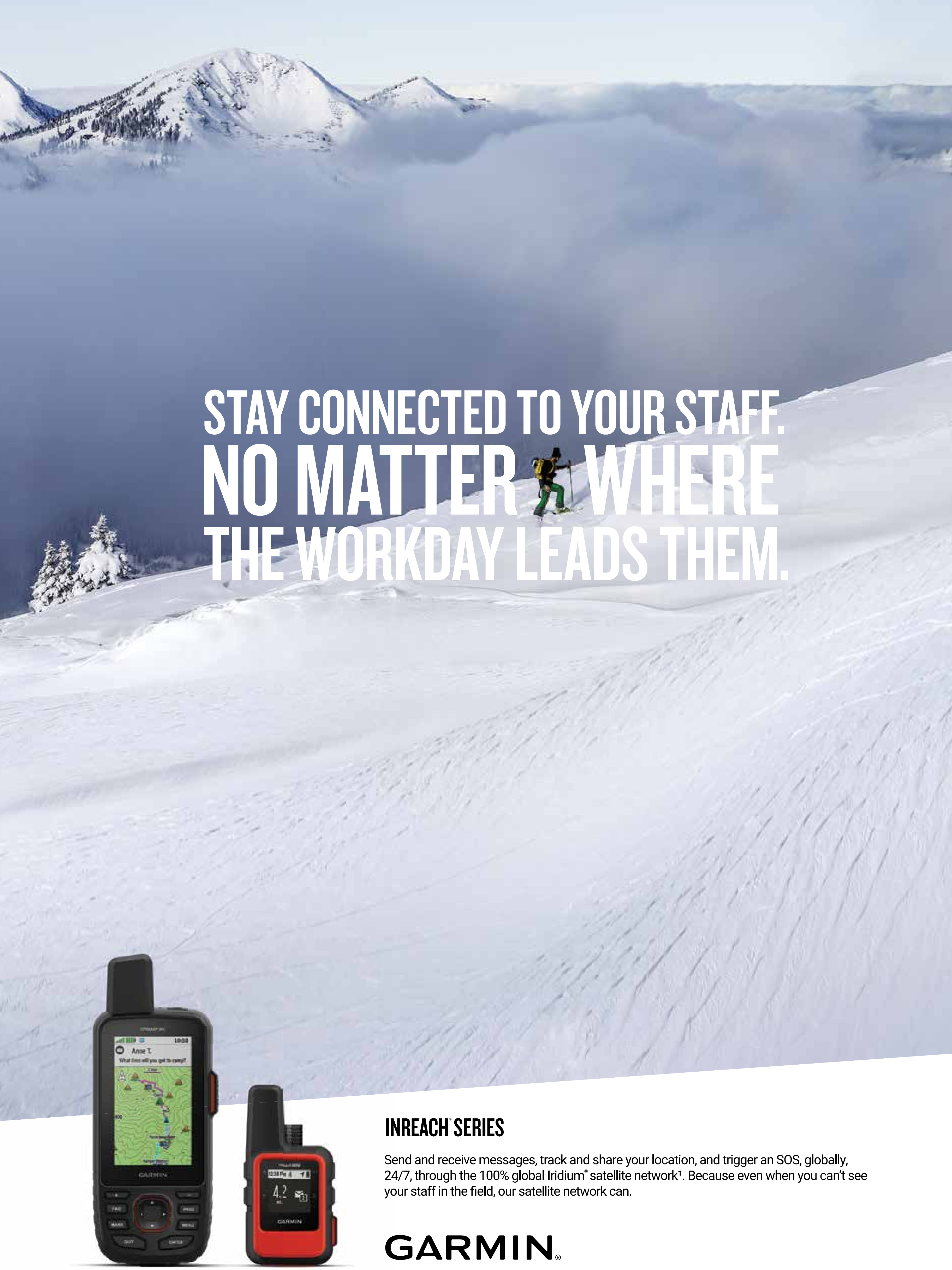

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TOOLS FOR THE UPCOMING SEASON

December shadows
grow
skis turned homeward

FEATURE STORIES

DEPARTMENTS

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.

A3 STAFF AND BOARD

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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Subscription: $35 per year (4 issues). Subscription is included with membership dues to A3. For subscription and membership information, see **www.AmericanAvalancheAssociation.org**.

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.

At the pre-NSAW party at 20 Corners Brewery I got to visit with my dear friend and continual inspiration Patty Morrison. Now if only I had opened my eyes for the picture...

HAIKU HUNT

Scattered throughout this issue are snow and avalanche-themed haiku composed by Jerry Roberts. Enjoy!

columns, needles, stellars
bounce off
midnight windshield

A3 AVSAR UPDATE

Over the last few years the American Avalanche Association (A3) has been working with industry professionals to craft proficiencies and guidelines for an Avalanche Search and Rescue course. This course focuses on organized rescue, and goes beyond the companion rescue covered in Avalanche Rescue Fundamentals, or any other recreational level avalanche course.

The course is designed for professional avalanche workers, including ski patrols and SAR team members (volunteer and paid including fire department and sheriff's office personnel). In conjunction with industry partners, A3 has developed the proficiencies and guidelines for this course that are now available on our website. While professional rescue courses have been offered in the past, this winter will be the first season that these courses will follow the guidelines set forth by the A3.

The following certified professional course providers will be offering 3–4 day AvSAR courses this season: American Avalanche Institute (AAI), Colorado Mountain College—Leadville, and Silverton Avalanche School (SAS). Please see their websites for dates, locations and price.

FROM THE EDITOR: Tools for the Upcoming Season

BY LYNNE WOLFE

SAW season just came to an end, leaving me simultaneously tired and energized. We work remotely on my A3 avalanche team. Dan K is in Bozeman, but he's pretty quick on reply with texts or phone calls. Kate Koons is just down the road in Victor, but she's been on the road in in the air a lot this autumn, meeting with course providers and guiding the Pro education program through growing pains and vision clarification. When she and I get together it's a mile a minute, as you can imagine, and while we each seek out the other's insights, overlap in our schedules is rare. Our graphic designer McKenzie Long and I also work remotely, mostly via Dropbox. I admire her creativity and vision so much; every so often we talk on the phone and we've met in person once.

I encounter you, my readers and authors, through the pages of TAR and the phosphorescence of email. When we connect in person, across the A3 table at a SAW or over a beer, I thrive on your energy, your ideas, and your experience. I want to know what you think about a presentation or how you used a TAR article in your practice. You inspire me, and in turn I want to share that inspiration.

Did you go to a local SAW this autumn? What tools or insight will you take into this winter? Look for SAW reports in the February TAR, and feel free to email me any comments on this topic.

Here's a collection of tools, tips, tricks, insights, and inspiration from our community for this season. Need a visual reminder of last year's avalanche drama? Black and white heightens contrast in the cover's deep slab images—Snowmass from master photographer Art Burrows and the craggy Sawtooth from Tanner Haskins. We can always use some numbers to back up our intuition. Here's an array of stories bringing data and subsequent insight into:

- weather patterns and deep slab problems (Andrew Schauer, p 16)
- a new formula for understanding inter-party avalanches in the busy backcountry (Charlie Hagedorn, p 18)
- an increase in the ages of avalanche victims (Erich Peitzsch, p 40)
- Jeff Deems, in a reprise of his recent CSAW presentation, offers clarity into digital mapping technology. He has some clear take-home messages as well. Thanks, Jeff, for punctuating your busy schedule with an assignment from TAR. (p 21)

I had a great time bringing together an array of decision-making tools for you in this issue.

- In his usual concise and entertaining fashion, Steve Conger has invented an acronym (no! not another acronym) to help us make quick, efficient, and accurate decisions. I might even try to HUCKEM this winter, but only if it's deep enough, haha. (p 36)
- Clinical psychologist and backcountry skier Sara Boilen cautions us about reverting to our "lazy brain" default setting on page 38.
- You guys know that Drew Pogge, formerly of Backcountry Magazine and currently of Montana Alpine Adventures and the Bell Lake Yurt, is now our A3 publications chair, and therefore my boss? I always need help balancing the intersection of guide and writing skills, and Drew is a pro on both counts. He shares some words of advice on selecting a backcountry partner on page 44.
- A3 at-large trustee Sean Zimmerman-Wall is a busy guy. So of course he has time to visit Croatia and write an article about his experience teaching avalanche rescue to the Croatian Mountain Rescue Service. (p 33)

Putting together a round table of ideas and reactions to a question is one of my favorite formats for TAR. I swing through Lou Dawson's Wild Snow often as he hosts topics that interest me personally and professionally (is there much difference?). When he featured an essay about going One at A Time (OAT) in avalanche terrain, I immediately saw it as a topic for a great backcountry round table. With Lou and Manasseh Franklin (Wild Snow's new editor)'s permission, we re-worked the essay, which I sent out to a select TAR commentary team. (p 24)

Finally, I welcomed Travis Feist's rant about a wedge between motorized and non-motorized parts of our avalanche community. He's got a good point, and I've begun a reply from the perspective of someone who cares a lot about both the reputation and the effectiveness of avalanche education and forecasting. What do you think? (p 45)

Have a great winter and stay in touch.

Rich Marriott and Mark Moore put finishing touches on their highly entertaining presentation on the history of the Northwest Avalanche Center, which was hosted on October 19 at 20 Corners Brewing in Woodinville, WA. Select proceeds from the sale of 20 Corners' concurrent special release of Storm Cycle IPA will benefit A3. Stay tuned to A3 social media for the link to a recording of this presentation.

FROM THE PRESIDENT

BY HALSTED "HACKSAW" MORRIS

For many of us, the SAW season marks the beginning of winter. In a way it's like the first day of high school, where you see your buddies and catch-up on what everyone did over the summer. The avalanche field is full of diverse and interesting folks.

This fall I attended CSAW here in Colorado and ran the A3 general membership meeting. It was great that we had a fair-sized turn out, considering that all those that attended had already sat through a day of presentations. Free beer always helps. Dan and the board are thinking about better ways to have the general membership meetings in the future. Maybe something online?

I was very pleased to announce at the meeting a new award that the A3 BOD's approved prior to the meeting. As I had mentioned in my TAR column (38.1), Sue Ferguson was really one of the leaders in starting A3 as the editor of *The Avalanche Review*. In her honor we have created a new award. It's fitting for this award to involve communicating information about snow and avalanches. The criteria for the award reads:

> **The Sue Ferguson Award** *recognizes individual(s) for their contribution in media communications about snow and avalanche sciences to the public and the American avalanche community. The awardee does not have to be a member of the A3 to receive this award. Generally, the Governing Board will initiate the nomination, but nominations may be submitted by A3 members in good standing.*

At the general membership meeting, former A3 president John Stimberis nominated John Branch, author of the *New York Times* article series *Snow Fall: The Avalanche at Tunnel Creek*, for the award.

http://www.nytimes.com/projects/2012/snow-fall/index.html#/?part=tunnel-creek

The A3 BOD will be voting on this award at its next board meeting. Do you have other nominations or an opinion?

I was also pleased to hear some comments at CSAW about my previous column on inclusiveness in A3. It has been great to receive feedback and suggestions from many folks. You will be seeing more recognition of women in the avalanche industry with their profiles in TAR.

What more can we do as an organization? Perhaps we could offer more scholarships awarded to women of A3 for such things as ISSW & SAWs and maybe Pro Training Courses (PTC). As I mentioned before, Avalanche Diva night at ISSW will still receive support. If you have any other suggestions, PLEASE feel free to email me at HM1Hacksaw@gmail.com. I want to wish everyone a great and safe winter!

FROM THE EXECUTIVE DIRECTOR

BY DAN KAVENEY

I love the dedication and enthusiasm our members have for the American Avalanche Association. The A3 Board and staff work hard to serve those members, and the community responds with a remarkable generosity of spirit: volunteering their time, enthusiasm, and money to help the organization. I've listed our donors over the past year or so below—by name as opposed to the size of the donation, as we've traditionally done. We're grateful for every contribution—no matter how large or small—and have always chosen to acknowledge everyone regardless of the size of his or her gift.

We know the money doesn't come easily, so the A3 Board and staff work hard to make sure we use the money you donate as effectively and directly as possible to promote avalanche safety through professional development, education, publishing, outreach, and research.

With your help we've accomplished quite a bit over past year: membership is up, sponsorships, scholarships, and grants have increased, outreach has expanded dramatically, and we continue to build on the successes of the Pro Training Program. We've been able to accomplish all these things while moving the organization toward a firmer financial footing. It has been a good year for us, and we couldn't have accomplished these things without the help of our donors and members.

Our corporate sponsors provide essential support that allows us to leverage your personal contributions to greater effect. We have four Diamond and Platinum sponsors: TAS, Backcountry Access, Wyssen Avalanche Control, and CIL Explosives. These very generous companies provide the support that forms the foundation for our Professional Development Grant, Research Grant, and Scholarship programs. We also benefit greatly from the generosity of our Gold and Silver supporters and TAR advertisers, who help sustain the organization through cash contributions, in-kind support, and merchandise. These organizations give back to the avalanche community, so I encourage you to support them in turn with your recommendations and business.

This year we've worked with our corporate sponsors to offer some tangible incentives for our donors. Please see the accompanying graphic for an outline of our donation incentives. These gifts will rotate throughout the season, so if you see something you really like act now! We've also upgraded some of our back-office software so you can now make recurring contributions on a monthly, quarterly, or annual basis. Donors who initiate a recurring gift of any kind will get a stainless steel A3 beer mug (with a built-in bottle-opener!!) while supplies last. Please go to https://aaa19.wildapricot.org/donate/ to make your contribution to avalanche safety and professional development.

I'll close with another big thank you to all our donors, sponsors, and members. Together we are A3, and we're making a difference.

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METAMORPHISM

COLORADO DEPARTMENT OF TRANSPORTATION

Nick Barlow joined CDOT in October 2019 as the Winter Operations Program Meteorologist. He joins Jamie Yount (Winter Operations Program Manager) and the new Statewide Avalanche Coordinator (personnel to be determined). Nick previously worked as a backcountry forecaster for the CAIC, and has been a professional member of the A3 since 2014.

COLORADO AVALANCHE INFORMATION CENTER

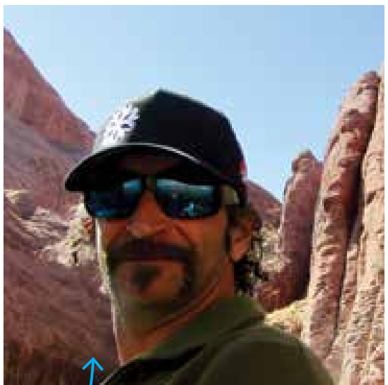
The CAIC is pleased to welcome Bill Nalli and Ryan Lewthwaite to team.

Bill Nalli began his "avalanche hunting" career at Solitude in 1996 when he moved to Utah from upstate New York. After some time as a mechanized and human powered ski guide he was hired as a highway forecaster with UDOT in the Southern Wasatch. Fifteen years later Bill is moving on from the UDOT Avalanche Program Manager job to relocate in Colorado. He starts this season as the CAIC Backcountry Forecaster in the north San Juan Mountains based out of Ridgway.

Ryan Lewthwaite joins the CAIC crew after a career with the US Forest Service. As the only Meteorological Technician forecasting for the Bridgeport Avalanche Center, he brings experience providing avalanche information to backcountry snowmobilers. Ryan previously worked as a winter Backcountry Ranger on Vail Pass & with the Chugach National Forest Avalanche Information Center (CNFAIC) in Girdwood, Alaska. Returning to Colorado is a welcome change for Ryan & his dog Summit, returning to familiar stomping grounds. Ryan will be an Avalanche Technician for the CAIC focused on the Front Range and Steamboat areas.

CHUGACH NATIONAL FOREST AVALANCHE INFORMATION CENTER

After five wonderful years, the Chugach National Forest Avalanche Information Center is sad to see **Heather Thamm** move on. During her tenure, she shared her diverse skill set and thoughtful perspective.



In addition to her competent forecasting and being a super fun field partner, Heather grew the center's workplace safety protocol by creating and implementing a formal field day debriefing process. While mentoring an intern, she put a large effort into examining the forecasting challenges in our region's unique climate when going to Low Danger with persistent weak layers. As a talented professional photographer she produced many avy-eye-candy photos, which have been a highlight of CNFAIC's advisories and observations. Heather will be missed by the CNFAIC staff and the Southcentral Alaska backcountry community. We wish Heather the best of luck in all her future pursuits!

With this transition the Chugach National Forest Avalanche Information Center is excited to welcome **Ryan Van Luit** to the forecasting team this season. Studying mass balance with the Juneau Icefield

Research Program in 1998 set the path for Ryan as a lifelong student of wild and snowy places. Ryan has worked on six continents and spent hundreds of days in the snow with students and clients as an outdoor educator, avalanche forecaster, and mountain guide. He is a professional member of the American Avalanche Association, the American Mountain Guides Association, and a certified Wilderness First Responder. Ryan is slightly obsessed with 3-dimensional puzzles, makes the best fermented pickles this side of Calgary, and is looking forward to calling Girdwood home for the winter.

UTAH AVALANCHE CENTER

The Utah Avalanche Center welcomes three new employees and one prior employee who has moved to a different position. The UAC is a mix of Forest Service and non-profit employees. After working for the non-profit for the last eight years in

winter storm brings
snow
and little sleep

various roles, Trent Meisenheimer was hired as a Forest Service Forecaster. Nikki Champion was also hired as Forest Service Forecaster for the Central Wasatch mountains. Andy Nassetta was hired by the non-profit UAC as an Outreach and Awareness Specialist. Hannah Whitney was hired by the non-profit UAC in the newly created Development Director position. We are very excited about the skills this group will bring to our team.

Trent Meisenheimer grew up in Salt Lake City Utah, skiing and snowboarding in the Wasatch mountains since the age of two. He has been working for the non-profit UAC since 2011 most recently as an avalanche forecaster for the Central Wasatch Mountains and as an avalanche education specialist. He produces and edits many of UAC videos such as the internationally acclaimed "Know Before You Go" video. Although busy with work, he is pursuing a Master's degree in Mechanical Engineering at the University of Utah, with a thesis related to snow and avalanche science. He has a passion for avalanches and devotes most of his time forecasting and teaching avalanche education in the winter months. In the summer months, he develops course material and curriculum for the Utah Avalanche Center and many others around the nation. In his free time, you can find him hanging from a rock wall or kayaking down one of the many scenic rivers in the western U.S.

Nikki Champion grew up spending her winters alpine ski racing throughout the hills of Michigan and escaping on family ski vacations to the Rocky Mountains. After high school, she moved west and began shifting her focus from alpine ski racing to backcountry skiing, mountaineering, and climbing as a way to explore the mountains while finishing up her Civil Engineering degree at Montana State University. During her winters in Bozeman, she did research in the sub-zero science and engineering lab and worked as an avalanche educator for the Friends of the Gallatin National Forest Avalanche Center. Following her time in Bozeman, Nikki interned with the Chugach National Forest Avalanche Information Center where she investigated avalanche release in relation to loading events and snow climates for Turnagain Pass. During the summer Nikki can be found riding her bike, trying to learn to surf and working as a mountain guide for RMI Expeditions throughout the Pacific Northwest and Alaska.

Andy Nassetta grew up on the east coast alpine racing, competitive slopestyle skiing, and then Freeski coaching at Killington and Okemo Mountain Schools. Andy moved to Utah in 2014 to attend Westminster College and found himself with wide eyes surrounded by "greatest snow on earth". Andy quickly realized that his skiing ability far exceeded his backcountry and mountain skills. While satisfying his education needs, Andy found his passion to educate others. Andy started with the UAC as a volunteer, then intern, then contractor, and now serves as the UAC Outreach & Awareness Specialist. He is eager to support the UAC mission by increasing outreach in rural areas and mountain regions by bringing basic avalanche awareness programs, such as Know Before You Go, to these communities.

Hannah Whitney grew up in small-town Maine, developing her love for the outdoors through adventuring around the abundant forests, ponds, oceans and more. Her appreciation for the outdoors has fostered a life full of outdoor recreation and environmental advocacy. Her passion for these things inspired her to move to the Rockies to study Ecology and Environmental Science at Western State Colorado University, where she was also involved with the Western State College Mountain Rescue Team and other nonprofit organizations in Gunnison and Crested Butte. Skiing at Crested Butte and the surrounding backcountry also deepened her love of skiing, and after graduation, she spent four years competing on the US Freeskiing Tour. During that time she moved to Utah where she has had numerous wonderful volunteer and work experiences with organizations such as SheJumps, the Utah Avalanche Center, TreeUtah and other local nonprofits. Most recently she worked as the Development Director for local nonprofit HEAL Utah, and is now excited to join the UAC team after an upcoming trip to ski volcanoes and travel in Chile.

KNOW BEFORE YOU GO PROGRAM UPDATE FALL 2019

KBYG
KNOW BEFORE YOU GO

BY CHAD BRACKELSBERG

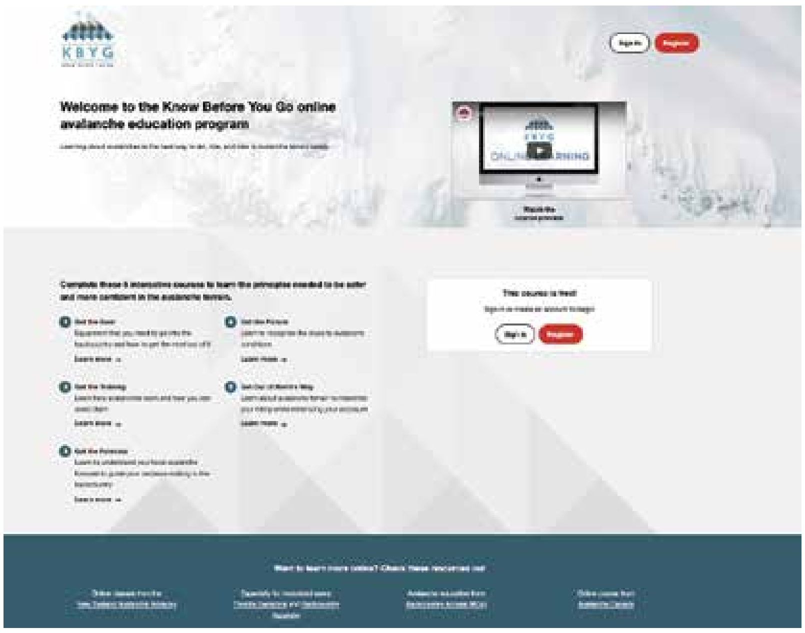
When the Know Before You Go (KBYG) concept was developed after the tragic death of four teenagers in the Wasatch Mountains of Utah on December 26, 2003, we never would have imagined that 15 years later the program would have grown to become a global standard for teaching avalanche awareness, translated into 11 languages, and used in over 30 countries. We are excited to see the program expand into new geographies each season. Last season, the program was translated into Japanese. This season we are working with the New Generation Ski school to help launch the program in 30 mountain communities in France, Switzerland, and Austria.

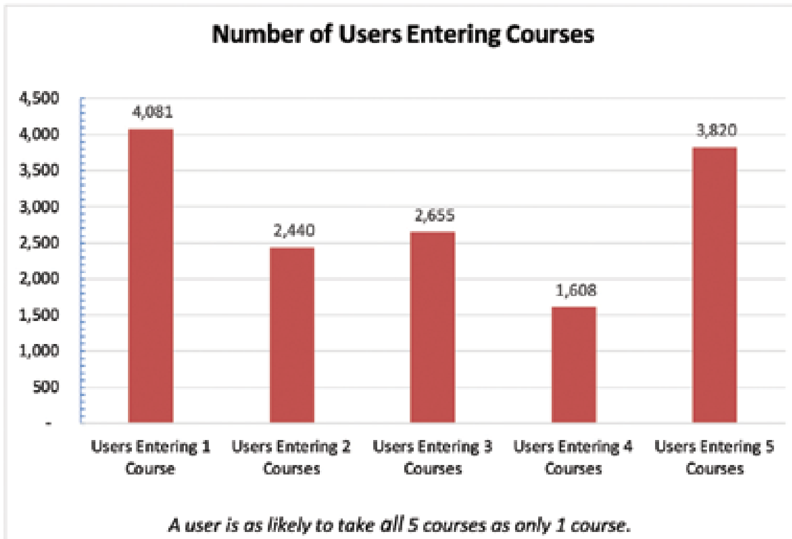
The KBYG video remains an important aspect of the program to demonstrate the importance of avalanche awareness using high profile athletes, stunning mountain footage, and simple messaging. Through the 2018-2019 season, the video had over 55,000 views, bringing the total reach of this video to over 753,000.

students for on-snow classes. The program also provides a valuable resource for experienced users to refresh or update avalanche skills.

The program was launched in November 2018 with the help of Inkwell Media and its large network of athletes and social media marketing expertise. As of April, the eLearning introductory video had been viewed over 300,000 times with 46,278 lesson completions! We teamed up again with Inkwell Media and their athletes to re-release the Avalanche Skills eLearning Program in fall 2019, with the goal of using it as a fall skills refresher. The eLearning lessons are a living and adapting program; we encourage avalanche educators to review the content, give us feedback, and consider using the content for their own classes.

This fall we released updated KBYG presentation materials. The slide deck used for the program has been updated with new images and videos and better speaker notes to promote a consistent KBYG message. If you have not received the updated presentation materials, please contact the Utah Avalanche Center (info@utahavalanchecenter.org).





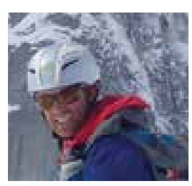
The biggest update to the KBYG program last season was the free Avalanche Skills eLearning program (kbyg.org/learn). More and more people are using online resources for self-directed learning. We developed this component of KBYG to meet their needs and provide another avenue for basic avalanche awareness. This eLearning program consists of five lessons focusing on the five points of KBYG (Get the Gear, Get the Training, Get the Forecast, Get the Picture, Get out of Harm's Way).

Each interactive lesson explains basic concepts and provides users with actionable tips they can adopt in the backcountry. With links to additional content, users can complete all five lessons in 2 to 4 hours. This program is not intended to replace an on-snow avalanche class but provides a pathway to more avalanche education. Many instructors are requiring or encouraging students to complete the program which introduces background concepts and prepares

What's next for KBYG?

- We are working on a formal KBYG instructor training program to train KBYG instructors remotely or in-person to enhance the quality of the KBYG program.
- We plan to begin work on a new KBYG video this winter, targeting a Fall 2021 release. We plan to partner again with groups like Sherpas Cinemas and Red Bull Media House for video content.
- We hope to create and release another 5-10 eLearning lessons going into more detailed topics like terrain management, rescue, and decision making.
- We are actively seeking additional KBYG sponsors to help pay for and promote the program and provide branding opportunities

If you are using KBYG or a portion of it in your avalanche education and awareness work, we'd like to hear from you to learn more about who is using the content, what others like and don't like, and how we can provide more content that will be useful.



Chad Brackelsberg is the Executive Director of the nonprofit Utah Avalanche Center. He is responsible for communications, marketing, fundraising, strategy, and UAC business operations. Chad spent the prior 20 years in the corporate world working for large consulting companies in technology consulting, program/project management, and data center operations. Chad is active in the Utah outdoor community and is an avid backcountry skier, ski mountaineering racer, ultrarunner, and mountain biker.

Debriefing a snow pit demo during an Avy 1 course at June Mountain. *Photo Jeff Pierce*

SOCAL SNOW AND AVALANCHE CENTER

BY JAKE CARPENTER

I currently work as a pro patroller at Big Bear Mountain Resorts in Southern California, as well as a volunteer at Mt. Baldy Ski Lifts; which is a small family-owned resort about an hour east of Los Angeles and holds some of the steepest and most sustained inbounds terrain in SoCal. Last season I started writing snowpack summaries for the SoCal Snow Avalanche Center, (socalsnow.org) as well as teaching avalanche courses. This winter I will be giving avalanche and winter travel safety talks around LA, as well as teaching avy courses in SoCal and the Sierra.

So Cal Snow Avalanche Center was founded by Allen Giernet following the tragic loss of three people in the San Gabriel mountains to avalanches. The center was launched in 2012–13 after consulting with Dale Atkins, Karl Birkeland, and the directors of Wallowa and Kachina Peaks avalanche centers.

TWO-WAY RADIOS AND BLACK SUBURBANS: LEARN THE NEW FCC RULES OR GET BOPPED

BY BRUCE EDGERLY AND JON SLAVIK

Attention all guides, avalanche schools, and casual radio users: it's about to get real out there. If you're currently "winging" it with your radio program, you could see a black Suburban pulling into your facility to enforce the new FCC rules. The U.S. FCC (Federal Communications Commission) is loosening up on the power and paperwork requirements for low-wattage "family band" radios, but they're now out to get those using uncertified, mainly Chinese-made high-power radios—especially if they're being used on unauthorized channels.

Background

Not unlike the world of avalanche transceivers, the two-way radio landscape has changed a lot over the past few decades. Newer technology has made high-power VHF radios more versatile, precise, and clearer at long range. The use of low-wattage family-band UHF radios has decreased with the omnipresence of cell phone coverage, decreasing user demand and "chatter" on those channels. As a result, the FCC has loosened up on UHF (ultra high frequency) radios—used by recreationists—but they've tightened up on VHF (very high frequency) and dual-band UHF/VHF radios—which most guiding and professional operations use. Here's what has changed and what you can do to prevent getting bopped:

FRS/GMRS (low-power UHF) radios

Generally referred to as walkie-talkies, these "family band" radios were made famous first by Dick Tracy cartoons in the 1970s, then by Motorola Talkabouts in the 1990s. Since then, their use has decreased due to competition with cell phones. In the backcountry world, they've seen a resurgence with the advent of BC Link radios from Backcountry Access (BCA). These channels operate from 462 and 467 MHz and are fully open to the public, which means they can get crowded if your radio doesn't have privacy codes. Up until 2017, the maximum power allowed for FRS (channels 8 through 14) was 0.5 watt. The maximum power allowed for GMRS (channels 1 through 7 and 9 through 22) was 1 watt—and the user was expected to pay an $80 fee and get a permit from the FCC if they happened to tune their radio to these channels. This latter rule was rarely enforced.

Starting in 2017, the FCC separated FRS and GMRS. They now allow a maximum of 2 watts on FRS radios, 5 watts on handheld GMRS radios, and 50 watts on non-handheld GMRS radios. The FCC also allows the use of repeaters for GMRS channels, just like they currently do for VHF channels. They claim that the FCC licensing requirement on GMRS will now be enforced.

Combination FRS/GMRS radios will no longer be allowed, except those which have been recertified as FRS radios by the manufacturer (including the BC Link). This loosening up of the FRS rules resulted in the development of BCA's BC Link 2.0 radio, which is an FRS-only radio that transmits at up to 2 watts, enabling clearer communication at longer range. It is compatible with all FRS and GMRS channels.

In addition, the FCC has also lightened up on the business use of FRS/GMRS channels. Until recently, these channels were only for non-commercial use. As of 2017, businesses are now allowed to use these channels. Of course, that includes guiding operations and avalanche schools.

Business/Pro (high power VHF and VHF/UHF) radios

These are the radios used by most guiding operations, ski patrols, sheriff's departments, and search-and-rescue groups—usually with repeaters to extend their range. This is also where the FCC is stepping up its enforcement, thanks to the proliferation of uncertified Chinese-made radios being sold online. Business radios all operate from 150 to 170 MHz and 450 to 470 MHz but the channels are not public: each radio fleet is assigned a private frequency by the FCC, to ensure that users don't interfere with each other—especially with public safety agencies that need to have clear communication during emergencies. To get your own frequency, you need to apply and pay on the order of $400 for a license from the FCC.

With improving technology in VHF/UHF radios, these units are more precise at operating within narrow bandwidths, the acceptable deviation in frequency on either side of the assigned "center frequency." Therefore, in 2013, the FCC narrowed the bandwidth at which these radios are allowed to operate. The good news is that enables the allocation of private frequencies to more user groups. The bad news is that if you don't have a license to operate at one of these frequencies then you're going to get bopped.

In addition to frequency poachers like this, the FCC is also nailing those who sell non-FCC-certified radios. If a radio is certified, that means the FCC has verified that it does not have software enabling users to program it to FCC-allocated frequencies. This process is only supposed to be performed by FCC-approved frequency coordinators using FCC-approved software. However, a black market of renegade consultants has sprung up over the years that are using illicit software to program radios illegally (for an exorbitant fee, of course). To determine if your radio is legitimate, look for an FCC identification number in the battery compartment. If the number isn't there, the radio isn't legal. To determine if your frequency coordinator is truly legit, see the FCC's website: https://www.fcc.gov/wireless/bureau-divisions/mobility-division/industrial-business/industrial-business-licensing.

The radio on the left has no FCC Identification number—and is therefore illegal to operate or sell. The radio on the right has an FCC ID number, which means it complies with Part 90 of the FCC regulations.

Getting bopped: an expensive proposition

- In 2007, the FCC caught Chugach Powder Guides using several frequencies for which they didn't have a license. A fleet of two black Suburbans and four FCC agents pulled up to their heli pad and immediately shut down their operations. Only after much pleading on safety grounds, according to CPG's owners, did the agents allow the company to proceed. They were forced to shut down their repeater in the Tordrillos that season and to pay up for a real FCC license. This happened early in the new enforcement era. Since then, the FCC has become less forgiving.
- A frequency consultant in New Jersey, Perez Communications and Electronics, was caught programming unlicensed radios just this year. He settled with the FCC out of court to avoid fines of $20,134 per day, retroactive several years.
- In 2018, the FCC raided a U.S. distributor of Chinese-made Baofeng radios when agents determined that the distributor was selling non-FCC-certified Baofengs. Agents confiscated all non-certified inventory, temporarily closing the business.

Keeping it clean

There are certain things you can do to avoid risking your operation to FCC enforcement:

- Check your radios to make sure they have an FCC certification number. If they don't, then get rid of them. You'd better not sell them on Craigslist: then you become an illegal seller.
- If your radios have an FCC ID number, then make sure that you're licensed to operate on your frequency. Ask the frequency coordinator that programmed your radios.
- If you programmed the radio yourself somehow, then make sure you programmed in a frequency that the FCC has assigned to you. Of course, if you did this then you probably have unlicensed radios.
- If your organization owns a frequency from the FCC and your organization operates in several regions, make sure that frequency has been allocated to you in all those regions, not just the region in which your headquarters is located.
- If you want to share frequencies with other agencies, then make sure you get written permission from them before going to a frequency coordinator to get a license for that frequency. A legit coordinator will need that permission before they will touch your gear. For instance, if you're a guiding operation that wants to share frequencies with the local ski patrol or SAR group. If you don't get their permission—and they don't like you—they can report you to the FCC.
- Consider using FRS radios and their open channels for communicating within groups when you're traveling in the backcountry. You can still communicate with your operations base and other agencies through your 5-watt radios and repeater system, but it's a lot less expensive and more convenient to use open channels. "Chatter" is not an issue if you're smart about using privacy codes (i.e. don't insist on using channel 4, privacy code 20—a popular one in the Colorado and Washington backcountry).
- It's worth noting that you're not allowed to use your high-power VHF/UHF radios to communicate with low-power FRS radios, unless it's an emergency. In fact, in a true emergency situation, all these rules go out the window. You just better hope that the agent that emerges from that black Suburban is a skier or snowmobiler—and understands your definition of an emergency (scoping untracked lines doesn't qualify!)

Bruce Edgerly is co-founder and vice-president of Backcountry Access, Inc. (BCA), a leading manufacturer of backcountry safety equipment, based in Boulder, CO. He loves to ski and drink cold ones with TAR editor Lynne Wolfe.

After growing up ski racing and boot fitting in the Midwest, **Jon Slavik** studied engineering at Colorado School of Mines. He designed snowboard testing equipment at Boa Technology and was involved with instrumentation for aerospace systems before coming to BCA. Jon is an avid backcountry snowmobiler and skier during the winter, and rides road, MTB, and enduro in the summer.

PATTERN RECOGNITION: MATCHING WEATHER TO DEEP PERSISTENT SLAB CYCLES

BY ANDREW SCHAUER

LOCATION	MAJOR SEASONS	MINOR SEASONS
Bridger Bowl	1979, 1980, 1984, 2011	1987, 1988, 1995, 1997, 2014, 2017
Jackson Hole	1979, 1982, 1985, 1994, 1996, 1997, 2001, 2004, 2008, 2009	1993, 1999, 2003, 2005, 2016
Mammoth Mountain	1985, 1987, 1996, 1997, 2001, 2006, 2008	1979-1982, 1984, 1986, 1988, 1989, 1991-1993, 1999, 2000, 2012, 2014-2017

Table 1: Seasons with major and minor deep persistent slab avalanche activity at each study site. The years listed represent the beginning of the winter season. For example, the 1979/1980 winter season is listed simply as '1979'.

Deep persistent slab avalanches are destructive and difficult to predict. My Master's research investigated weather and avalanche records in order to better understand the atmospheric processes related to deep persistent slab avalanches and hopefully make them a little easier to forecast. We used a framework similar to numerous published studies exploring synoptic controls on snowfall, precipitation, avalanches, and other phenomena (e.g. Birkeland et al., 2001; Fitzharris, 1987; Hatchett et al., 2017; Kidson, 2000; Wise, 2012), but specifically focused on deep persistent slab avalanches.

We investigated events at Bridger Bowl, MT; Jackson Hole, WY; and Mammoth Mountain, CA, defining a deep persistent slab avalanche as any event in which the crown depth exceeded one meter and the failure layer was a persistent weak layer. We did not include avalanches failing at the interface between new and old snow, nor did we include fresh wind slabs. A snowpack conducive to deep persistent slab avalanches usually forms as a result of early-season weather patterns, and a persistent weak layer may exist in the snowpack for weeks or months before being pushed to its breaking point by a single weather event such as heavy precipitation, rapid warming, rain, or wind loading. While mountain weather is highly complex and spatially variable, it is driven by atmospheric systems operating on the synoptic scale (1000s of km). Therefore, by describing relationships between synoptic-scale atmospheric circulation patterns and deep persistent slab avalanches, we hope to enable practitioners to better anticipate these difficult to predict events.

We classified daily 500-milibar geopotential height maps for 39 winter seasons using Self-Organizing Maps (SOM) to characterize wintertime atmospheric circulation over North America. A SOM is a type of artificial neural network that uses unsupervised machine learning to identify a user-specified number of recurring patterns or 'nodes' in a multidimensional data set. Collectively, the nodes summarize all modes of variability across a data set. Once the nodes are generated, each observation in the record is assigned to the node with which it is best represented. In this case, the nodes generated with the SOM represent 20 synoptic types that collectively describe the major atmospheric patterns observed over North America during the study period. Each day in the record is assigned to the synoptic type that best resembles the daily 500 mb height map.

By recognizing recurring atmospheric patterns (i.e. synoptic types), we were able to examine typical local weather and snowpack characteristics at each of our three study locations during certain atmospheric configurations. We used descriptive statistics to summarize daily maximum and minimum temperature as well as daily precipitation for each of the 20 synoptic types at the three study sites. At each of the three study locations, we found the warmest synoptic types to be associated with upper-level ridging and enhanced airflow out of the southwest. Conversely, the coldest synoptic types were associated with upper-level troughing and a more northerly flow. At Bridger Bowl, the largest and most frequent storms were associated with a ridge situated over the Pacific Northwest, localized troughing and a resulting northwest airflow. While some of these synoptic types also favored precipitation in the Jackson Hole area, the wettest patterns around Jackson tended to feature enhanced zonal flow (directly out of the west with little north/south movement). Mammoth Mountain received the most precipitation with a slight southwesterly airflow. At all three locations, the synoptic types associated with major storms appear to be closely tied to local and regional topography, with the largest and most frequent storms occurring during synoptic patterns that transport moisture inland from the Pacific while encountering the fewest orographic barriers. This finding aligns with previous research and supports anecdotal observations at all three study sites.

We used historical records of in-bounds avalanches to identify seasons that had unusually high deep persistent slab avalanche activity as well as those that had little to no deep persistent slab avalanches at each of the three sites (Table 1). At each site, we counted the number of days assigned to each of the 20 synoptic types during November-January of the major seasons and compared those counts to the number of days assigned to each synoptic type during the same months in the minor seasons. At Bridger Bowl and Jackson Hole there was an increase in the number of days represented by synoptic types corresponding with a positive phase of the Pacific-North American teleconnection during the beginning of major seasons. These conditions are characterized by a blocking ridge over the Rockies and troughing over the Aleutian Islands and eastern North America. This type of atmospheric configuration rarely results in precipitation at Bridger Bowl or Jackson Hole, which yields a shallow snowpack and enhanced weak layer development during the beginning of the major seasons at both sites.

The driest conditions at Mammoth Mountain tended to occur when the ski area was situated under or directly downstream of an upper-level ridge, or with a zonal pattern moving out of the northwest. While there were a large number of days assigned to these synoptic types during Nov-Jan of major seasons, there were also a large number of days assigned to synoptic types that are associated with heavy snowfall. This finding seemed counterintuitive initially, since heavier early-season snowfall tends to impede development of basal facets. However, we found that most deep slab activity at Mammoth occurs during the first half of the season. During the seasons that were entirely dominated by dry synoptic patterns (e.g. 1988/89, 1989/90, 1991/92, and 1993/94), there was simply not enough snow on the ground to build a slab thick enough for a deep slab avalanche.

At all three study sites, we found an increase in the number of days represented by synoptic types commonly associated with precipitation during the 72 hours prior to deep persistent slab activity. When we isolated the wet slab avalanches, we found an additional increase in the number of patterns that were characterized by southwesterly zonal flow and typically associated with warm temperatures as well as precipitation. These warmer synoptic types were not present prior to onset of dry deep slab activity, and would likely lead to introduction of liquid water in the snowpack, which is prerequisite to wet slab avalanches.

The February 1986 Avalanche Cycle

We revisited the February 1986 avalanche cycle, during which major avalanche events were observed across most of the western U.S. Birkeland and Mock (2001) attributed the cycle to abnormally large snowfall totals, as opposed to an unusually weak snowpack. The event was particularly interesting in the context of this research because while Jackson and Mammoth both saw major avalanches, Bridger Bowl did not experience any unusual activity. This can be explained largely by the atmospheric patterns observed immediately prior to and during the cycle, which were characterized by an omega high over the Bearing Sea, troughing over northern Canada, and a southward shift in the North American storm track coupled with zonal/southwesterly flow over the continental U.S. (*Figure 1*). This type of circulation has historically favored precipitation at both Jackson Hole and Mammoth Mountain, often leaving Bridger Bowl with smaller precip totals, and February 1986 was no exception. From February 13-18, Mammoth Mountain saw 538 mm SWE, Jackson received 211 mm, and Bridger was left with only 33 mm. As a result, Bridger Bowl did not see the kind of activity that was observed across much of the west. During this time frame, our SOM-generated synoptic types align very well with the composite chart presented in Birkeland and Mock (2001) (*Figure 1*). This cycle provides an encouraging case supporting the use of SOM-based synoptic typing to investigate weather and avalanche records.

In this study we examined historical records using a novel approach to identify and describe patterns that have been observed by practitioners at our study sites for years. We combined a synoptic level analysis of early season conditions with an analysis of triggering periods. In doing so, we hope to validate those observations by describing them in concise terms, and in a way that can hopefully lead to longer-term forecasting of deep slab avalanches through analysis of forecasted synoptic products. This research can also improve the learning curve for young practitioners or those that are unfamiliar with a new forecast area. The framework of this study is replicable for anybody that has maintained long-term avalanche, weather, and snowpack records. The analysis is implemented in the free statistical software R, and the script for the functions used in the analysis is included in Appendix C of this thesis, which can be found at https://avalanche.org/wp-content/uploads/2019/06/schauer.pdf. ⬢

In February of 1986, after a huge deep slab avalanche almost reached houses at the base of Jackson Hole Mountain Resort, Renny Jackson and Rod Newcomb went to investigate. *Photo Renny Jackson*

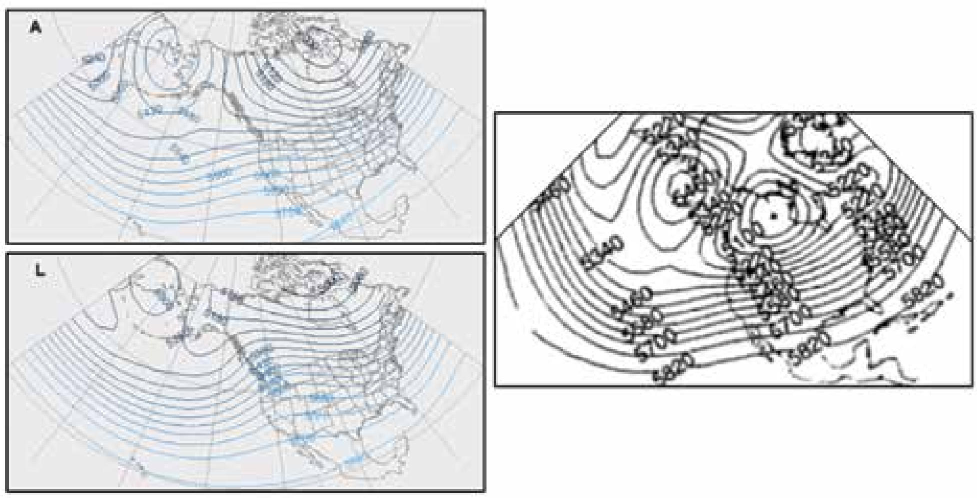


Figure 1: SOM-generated synoptic types observed during the February 1986 avalanche cycle (left). Composite chart for the same time period (right), adapted from Birkeland and Mock (2001).

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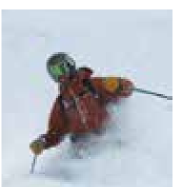
This research was conducted under the guidance and mentorship of Jordy Hendrikx (Montana State University Department of Earth Sciences Snow and Avalanche Lab), Karl Birkeland (USFS National Avalanche Center/MSU Dept. of Earth Sciences), and Megan Higgs (MSU Dept. of Mathematical Sciences). Cary Mock provided preliminary feedback regarding the atmospheric classification. Bridger Bowl, Jackson Hole, Grand Targhee, and Mammoth Mountain ski patrols provided avalanche records for this project. Special thanks to Pete Maleski, Ella Darham, Richard Griffen, Doug Richmond, Alex Marienthal, Ned Bair, Chris McCollister, Bob Comey, and Patrick Wright for helping me track down records and for lengthy discussions on weather and avalanches. This project was funded in part by the A3 Student Research Grant and the A3 ISSW Scholarship.

Andrew Schauer recently earned a Master's degree from the Montana State University Dept. of Earth Science Snow and Avalanche Lab. He lives in Livingston, MT, where he is an avalanche educator and GNFAC superfan. He is currently collaborating with researchers at MSU and UNIS Svalbard on several ongoing projects and waiting patiently for the right avalanche center to take him on as a forecaster.



INTER-PARTY AVALANCHE INVOLVEMENTS: A MODEL AND A CONVERSATION

BY CHARLIE HAGEDORN

Inter-party avalanche involvements: Do they happen? What can we learn about them?

First: Yes. Inter-party involvements happen. Since 2001, at least six-to-eight people have died in North American avalanches triggered by another party.

Second: A simple model for inter-party involvements suggests that the rate of inter-party involvements may grow like the density of parties **squared** and that the inter-party involvement rate is proportional to avalanche size. As a rule-of-thumb, inter-party incidents have happened when there was more than one party per twenty avalanche-areas. See definitions below.

A possible inter-party incident in December 2015 drew me deep into this subject. As the number of people entering the winter backcountry of the Cascades continues to grow, I wondered how the rate of inter-party incidents might grow. That exploration led to a paper: *Inter-Party Avalanche Involvements May Increase Quadratically With Party Density*. The paper is written for you—this article is the movie-trailer to pique your interest in reading the real thing.

A MODEL:

The paper constructs a simple model as a foundation for conversation about inter-party incidents. Two quick definitions: For this article, an avalanche "involvement" is when a party and an avalanche touch. An "incident" is an event in which at least one involvement occurs.

The model has the simplest of beginnings—the assumption that the rate ($R_{single\text{-}party}$) at which parties trigger avalanches is proportional to the number of parties ($N_{parties}$) in an area A.

$$R_{single\text{-}party} = r_0 N_{parties}$$

It is convenient (trust me) to switch to a notion of party densities, where $n_{party} = N_{parties}/A$:

$$r_{single\text{-}party} = r_0 n_{party}$$

An inter-party involvement requires two events: First, a single party must trigger an avalanche and second, at least one other party must be unlucky enough to be within the avalanche, with area $A_{avalanche}$. We've handled the first with $R_{single\text{-}party}$. If we assume parties are equally-likely to be anywhere in our area, then the expected number of parties struck by an avalanche is $(N_{parties}-1)A_{avalanche}/A$, so

$$R_{inter\text{-}party} = R_{single\text{-}party}\,(N_{parties}-1)\,\frac{A_{avalanche}}{A}$$

For simplicity (the qualitative conclusions are the same), we'll approximate $(N_{parties}-1)$ as $N_{parties}$ and switch to densities again.

$$r_{inter\text{-}party} \approx r_0 n^2_{party} A_{avalanche}$$

This is a key result. The model suggests that the rate of inter-party involvements grows like the **square** of the density of parties. If there are twice as many parties, there will be *four* times as many inter-party involvements. Furthermore, the inter-party avalanche involvement rate should grow when the day's avalanches are larger. These conclusions are not earth-shattering, but they help to make discussion of inter-party incidents more precise.

There is a second question we can ask, and it has an actionable answer: "For this model, at what party-density will inter-party involvements become a meaningful fraction of all involvements?"

First we need the overall involvement rate:

$$r_{involvement} = r_{single\text{-}party} + r_{inter\text{-}party}$$

Simple enough, right? Using our results from before, this can be suggestively-arranged as

$$r_{involvement} = r_0 n_{party}\,(1 + A_{avalanche} n_{party})$$

This has a useful interpretation for forecasters, land-use planners, and backcountry travelers: The model suggests that when $n_{party}A_{avalanche}$ approaches one, a party is as likely to be involved in an inter-party incident as it is to trigger an own avalanche, as seen in Figure 1. Indeed, as we will see shortly, every inter-party avalanche incident examined in the paper had $n_{party}A_{avalanche} > 0.03$, and most were closer to 0.1. Forecasters will note that this observation sidesteps the hard part of forecasting—determining r_0. On a day when only D1 slides are likely, inter-party incidents are, outside of constrained terrain, *much* less likely than on days with D2.5+ avalanches.

DISCUSSION:

With this model in hand, we can consider its implications for travel practices. In particular, it focuses our attention on party density and avalanche size.

Terrain, access, and timing tend to focus parties into small areas. In a narrow couloir, two parties alone can have urban density. On a deep storm day, arduous trailbreaking means that parties can pile up into a paceline on a single skintrack—when those clumped parties begin to ski, they will be close to each other. In a large bowl, multiple snowmobile parties can choose to high-mark or rest in terrain with overlapping avalanche paths. On an optimal-conditions day in the big mountains, parties can queue up at constrictions on big routes—in April 2019, reportedly 16 people attempted to ski the Grand Teton on a single morning. On both small scales and large, we must not become too crowded, lest we begin to harm ourselves.

Until we can control the weather, avalanche size is largely out of our control, but as avalanche size

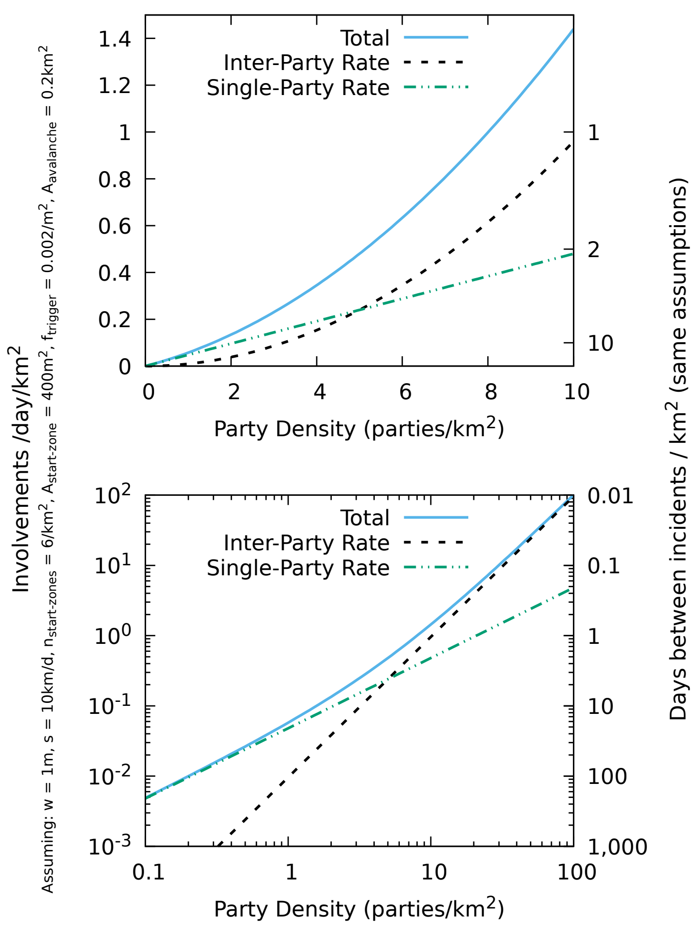


Figure 1: Illustrative plots showing the model's prediction: quadratic growth in inter-party involvements surpassing linear growth in single-party incidents when $n_{party}A_{avalanche} = 1$. For an 0.2 km² avalanche, as in this example, this occurs at n_{party} = 5 parties/km². The vertical axis in these plots varies *greatly* from day to day with snowpack properties, but the ratio of single-party involvement rate to that of inter-party involvements does not. Please note that the vertical axis (and the intersection of the inter-party and single-party lines) can vary day to day.

Incident	Avalanche Type	A (km²)	$N_{parties}$	n_{party} (parties/km²)	$A_{avalanche}$ (km²)	$n_{party}A_{avalanche}$
Lizard Range	Wind Slab, cross-loading	2-4.5	3+	0.7-1.5	~0.1	0.04-0.3
Empress Lake	Dry Slab	~1.2	2	1.6	~0.05	0.05-0.1
Nisqually/Wilson	Slab	~1.3	3+	≥ 2.3	~0.02	0.03-0.08
Boulder/Turbo Mountain	Persistent Slab	1-2	30-100	15-100	~0.2	3-20
Eagle Pass (possible)	Slab	1-2	2-3	0.5-3	>0.3	0.15-3
Taylor Mountain	Hard Slab	~0.8			>0.3	
Kendall Peak (possible)	Slab	0.2-1.0	3-9	9-15	0.003-0.01	0.03-0.15
Avalanche Crest/ Rogers	Slab	2-5	5+	1-5		
Grandfather Couloir	Loose snow	~0.16	2	~12.5	0.02-0.08	0.3-1
Mount Herman	Wind Slab	0.4-1.2	2+	>2-5		
Hawkins Mountain	Soft Slab	0.6-1	2-3	2-5	0.03-0.05	0.06-0.25
Temptation, Bear Creek	Soft Slab	0.3-1.3	2+	1.5-7	~0.03	0.05-0.2

Table 1: Measurements from selected inter-party incidents. Estimating A, the area of connected terrain, is subjective and uncertain. The model predicts that inter-party involvements become likely as $n_{party}A_{avalanche}$ approaches 1. Eleven out of twelve incidents involved slab avalanches.

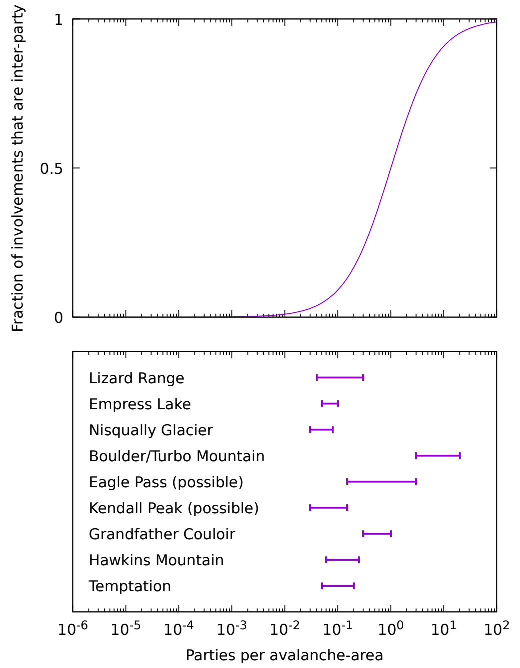


Figure 2: Upper panel: Approximate fraction of inter-party avalanche involvements as a function of party-density, measured in units of avalanche-area. Lower panel: Approximate values of $n_{party}A_{avalanche}$ as discerned from the historical record of inter-party avalanche incidents and near-misses. All but three incidents occurred with $n_{party}A_{avalanche}$ near 0.1.

Author's note: To me, Figure 2 is the most important figure in the article—it says that the model may have predictive power.

grows, we must be increasingly attentive to those above and below us. When slides are sufficiently large, they can propagate (and run) to or from locations that are out of sight. Simultaneously, a larger slide is more-likely to find (or be triggered by) another party.

INCIDENTS:

The paper examines thirteen inter-party incidents and near-misses in North America. The fatal incidents are enumerated in the sidebar. The twelve events amenable to quantitative study are shown in Table 1.

There are commonalities among these incidents. As we can see from both Table 1 and Figure 2, the inter-party incidents occurred with $n_{party}A_{avalanche} > 0.03$, and most near 0.1, in qualitative agreement with the model's prediction that values approaching 1 should be significant. Furthermore, after Krause's suggestion to include avalanche character, it became clear that all but one of the incidents involved a slab avalanche. The reason isn't known, but it is a clear signal in the small sample of incidents.

MITIGATION:

As the number of people in the backcountry continues to grow, it will be useful to have strategies in-hand to limit inter-party incidents. Here are suggestions to spur that conversation:

Awareness: The most direct approach is to raise awareness of the potential hazard. Nobody wants to trigger nor be impacted by an inter-party avalanche. If parties are aware of the hazard, they can make choices to protect themselves and others.

Density reduction: If we spread out, we won't hurt one another. There are still lonely places left to travel, even if they are harder to get to. Inter-party hazard can also be a selling point for those interested in expanding wintertime access for all forms of winter recreation.

Travel practices: We can practice "defensive routefinding"—choosing routes where we cannot be impacted from above, avoiding large-path terrain traps when human-triggering is likely, choosing truly safe spots to linger, and entering avalanche terrain only when we "must." In some situations, active measures may be appropriate—attempting to make contact by voice with out-of-sight parties in constrained terrain. Choosing not to descend nor ski-cut otherwise-attractive routes where people may be below may be an unpleasant choice in the moment, but it is an easy choice to live with.

Regional travel standards: When densities are high enough that nearby parties are a perpetual concern, predictable movement is important. Common run-lists may improve communication between parties. Terrain-specific traditions—up-only and down-only routes may minimize the risk for slow-moving ascending parties. A trail-head "run board", akin to a public flight-plan register, could enable the coordination of parties who may have never meet.

FATAL INTER-PARTY INCIDENTS:

Lizard Range, Fernie, BC (2001): A party of skiers in poor visibility ski-cut the top of a drainage. The resulting slide ran out of sight around a corner; the party opted not to ski the route. The slide struck a party of thirteen. Two fatalities.

Empress Lake, Monashees, BC (2004): A snowmobiling party jumped a cornice onto a slope, disabling a machine mid-slope. A second party crossed above, triggering a slab. One fatality.

Boulder/Turbo Mountain, Revelstoke, BC (2010): A snowmobile festival of roughly two hundred people was struck by a D3 slide triggered by a high-marking participant. Up to forty were buried. Two fatalities.

Eagle Pass, Revelstoke, BC (2010—possible): A party of snowmobilers may have triggered a D3.5 slide above two parties comprising nineteen people. One fatality.

Kendall Peak, Snoqualmie Pass, WA (2015—possible): A solo skier disappeared on a stormy day, recovered six months later. Injuries were consistent with avalanche. Investigation found that two parties had triggered slides uphill of the burial location on the disappearance-day. The cause of the accident remains uncertain.

Temptation Path, Bear Creek, CO (2019): A party of snowboarders triggered a slab in constrained permanently-closed terrain adjoining a ski resort. The slide crossed a popular trail, and the party beacon-searched the debris. A beacon-less solo skier was discovered by probe-line the following day. One fatality.

mountain disappears in storm
skiing on memory
and instinct

Figure 3 (left): Start zone and upper portion of the fatal February 2019 inter-party avalanche in Bear Creek, outside of Telluride, Colorado. The dashed red line indicates the triggering rider's path of travel. The blue line is the initial avalanche crown. The red circle highlights the location of two party members at the time of the avalanche, and the dashed blue arrow is the Temptation avalanche path. The boundary of Telluride Ski Resort is along the ridge.

Figure 4 (right): View of the avalanche debris at the bottom of the Temptation avalanche path. The dashed blue arrow marks the avalanche path. The blue line outlines the debris. The red circle denotes the solo-skier's fatal-burial location. The dashed yellow line is the approximate location of the Bear Creek Trail. *Photos Jeff Davis, courtesy of CAIC*

Until we can control the weather, avalanche size is largely out of our control, but as avalanche size grows, we must be increasingly attentive to those above and below us.

Radios: Radios are already a powerful tool for intra-party communication—they can also connect parties. Some regions, Telluride's Bear Creek in particular, have begun to define FRS/GMRS community radio channels for coordination between parties. From afar, the effort appears encouraging. There may be an opportunity for backcountry radio manufacturers to add second channel-monitoring functionality to avoid cluttering inter-party communication with intra-party chatter.

CONCLUSION:

As more people enter the wintertime mountain environment, we must find ways to play well together. If the model presented above is correct, we will need to limit our density and give greater consideration to neighboring parties as avalanche size grows. A combination of mitigation strategies is likely to be needed, with awareness of inter-party hazard chief among them.

If this subject has caught your interest, please check out the full-length paper. You can find it on the arXiv at https://arxiv.org/abs/1910.10668 or at www.kendallpeak.org.

ACKNOWLEDGMENTS:

Thank you to Susan Ashlock for her support for and tolerance of this project; Peg Achterman for a key conversation; Bruce Jamieson for suggesting the Lizard Range and Empress Lake incidents; Doug Krause for directing attention to inter-party avalanche problem-type; Jason Alferness, Dallas Glass, B.J., D.K., and Mark Vesely for key references; S.A. and John Greendeer Lee for proofreading and suggestions; Lynne Wolfe for placing this work where it can be seen; and finally, the avalanche/search-and-rescue organizations who have not only saved or recovered so many, but also recorded the documentation needed to help us prevent incidents in the future.

This nights-and-weekends work was indirectly supported by CENPA and the National Science Foundation (PHY-1607391 and PHY-1912514).

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DO YOU KNOW WHAT YOUR MAP KNOWS?

Understanding digital tools for better route planning and travel habits

BY JEFF DEEMS

In recent years many low cost digital mapping tools have emerged, bringing data sets that used to be squarely in the domain of specialists with expensive software into widespread public use. It is now common for backcountry riders to plan routes in advance, with distance measures, slope angles, forest cover, land ownership, and other relevant data, or to navigate in real time and revisit or share completed tracks. In some cases, these tools are linked with guidebook information and/or crowdsourced route content. Use of these tools is regularly integrated into avalanche education courses.

But, as with any tool, they have limitations—and in this case the limitations are not obvious and may even be hidden by implied precision.

Unfortunately, digital terrain information appears to have played a role in recent avalanche accidents by steering users into unintended exposure. Due to the nature of this digital terrain information, and the manner in which we tend to interact with these tools, this factor likely occurs frequently but without obvious consequence.

In this context, it is worth asking a couple questions to explore the potential pitfalls and proper use of these interactive digital maps:

Are we making accuracy assumptions when using digital mapping tools?

Are there best practices which will help us use these tools more effectively?

THE DIGITAL ELEVATION MODEL

All of the current route-planning apps have one thing in common: they exploit digital models of terrain.

There are a number of ways to display and convey terrain elevation, and they have evolved over time from flat paper maps to modern digital data sets in concert with measurement methods and display technology. Older maps used artistic techniques like hachures to convey relief in a semi-quantitative way, and were largely replaced by contour maps, which more accurately quantify elevation and relief, with each contour tracing a line of equal elevation. These days we are accustomed to interacting with digital elevation maps and shaded relief to convey elevation in a software environment that allows us to exploit multiple data sources at once (*Figure 1*).

This digital source—the Digital Elevation Model or DEM—is the fundamental data set for terrain analysis. This data format is *Digital*—the information is stored electronically; it stores terrain *Elevation* information—the land surface height above some reference elevation like sea level; and most importantly, is a *Model*—an abstraction or representation of reality, in this case typically arranged in a regularly-spaced grid. The statistician George Box provided probably the most eloquent summary of the topic here when he famously stated: "*All models are wrong, some are useful.*"

There is utility and power for us in knowing more about ways in which these models can be wrong, so that they can be most useful to us in managing avalanche danger.

Not all terrain models are created equal. The method by which a specific DEM was created depends on its date of creation and what source data was available. Elevation source data can be collected from field surveys, airborne or satellite camera imagery, or active remote sensing techniques like radar or lidar. Until the advent of computerized mapping tools in the 1980s and 90s, the predominant elevation resource in the United States was the 7.5' quadrangle map series, produced by the US Geological Survey through analysis of overlapping aerial photographs. Using a device called a stereoplotter, a technician would manually trace lines of equal elevation—contour lines—to produce each paper quad map. Most DEMs available today through the US National Map are these same data—created by digitizing the paper 7.5' quad maps, and interpolating the contour line elevations to a regular, 30-meter grid—one elevation value every 30 meters. These 30m data sets have since been re-interpolated to a seamless 10m data set, and this is the DEM source most widely available in the continental US.

Beginning in the early 2000s, several space missions provided globally available elevation data. The ASTER sensor on NASA's Aqua and Terra satellites produce 90m resolution elevation models from stereophotos, while the Shuttle Radar Topography Mission (SRTM) produced 90 and 30m DEMs using radar interferometry. Though they have been improved by recent reprocessing, these DEMs have specific shortcomings in forested or rough terrain and should be treated with caution at fine scales.

DEMs generated these days are commonly based on remotely sensed lidar data or on high-resolution satellite photos, either of which allow 1- or 2-meter resolution terrain data to be generated at high accuracies. Lidar has the additional advantage of being able to map under forest canopies, producing 'point clouds' of elevation measurements of the forest and the bare surface. These point clouds are then aggregated to a DEM, and provide an accurate reference against which to evaluate the more commonly available data sets.

Because of this variety of elevation measurement technology, mapping techniques, and sensor resolution, DEM accuracy varies by location. Different techniques and measurements have varying ability to map surface elevation in complex terrain or under forests. Errors also result from the digitization and interpolation methods. Additionally, terrain features that are smaller than the grid size can be missed (more on that in a moment). The end result is a complex and spatially variable pattern of elevation errors and data quality. These errors can present as a bias, as systematic errors, or as spatially correlated errors—separately or in combination. Importantly, it is not obvious to a digital map user which data source is in use, or what the DEM accuracy might be in a specific area.

In most of the continental US, the most widely available DEM is the 10m NED DEM, digitized from pre-1979 topo maps, and while some specific areas have been mapped with lidar, even those lidar resolutions vary from 1 to 5 m depending on the technology used for the survey. High-res lidar coverage is increasing steadily due to USGS 3DEP and FEMA floodplain mapping programs, so the data availability is continuously evolving. Alaska typically has lower-resolution DEMs, with

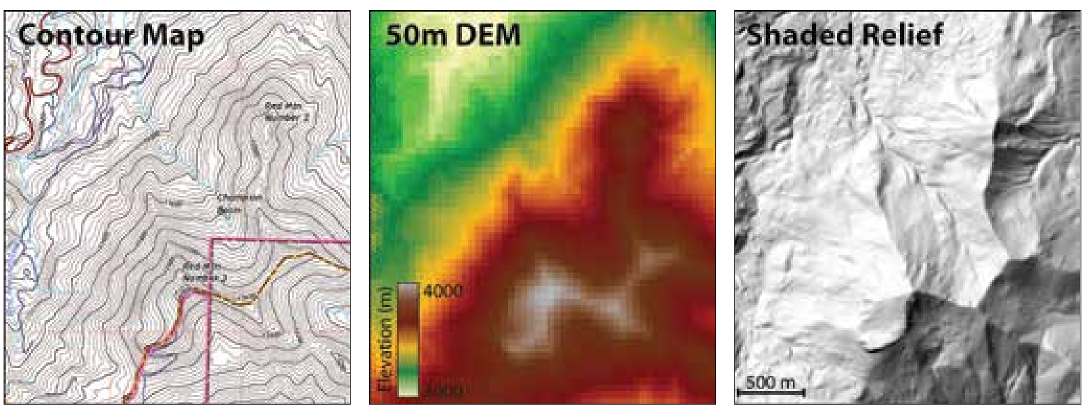

Figure 1: Three representations of the same terrain: a contour map, a Digital Elevation Model, and a shaded-relief image derived from the DEM.

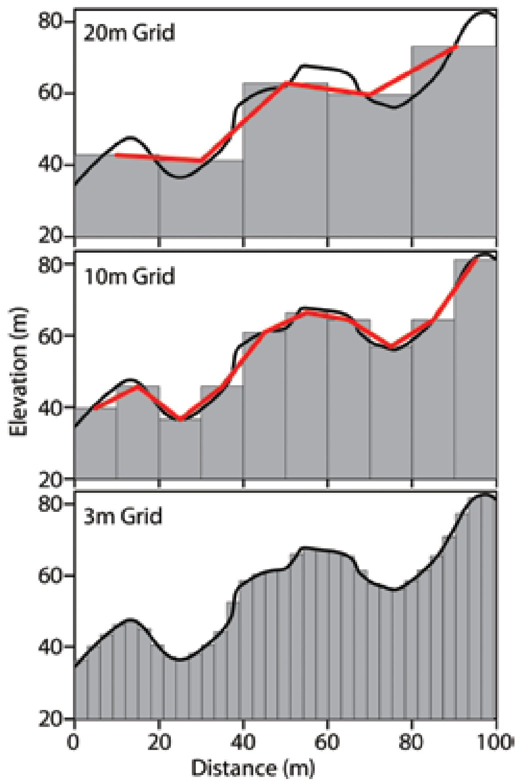

Figure 2: Schematic elevation profiles for 20, 10, and 3m DEM resolutions, with the gray bars representing the profile of grid cell elevations, and the black line representing the true terrain profile. As the DEM grid is coarsened, the ability to capture terrain variations and accurate slope angles decreases. *(after Hengl and Evans, 2009)*

30m SRTM DEMs being the current standard, though the USGS is currently building out a 5m radar DEM. Globally, the mix expands further, adding national mapping programs with similar technique, resolution, and accuracy variations as we have in the States.

SLOPE ANGLE MAPS

When the concern is with navigating and route-planning in avalanche terrain, slope angle is the terrain feature of primary interest rather than simply elevation values. Slope angle is defined as the change in elevation (Rise) divided by the distance over which that change occurs (Run). Rise divided by Run and a little trigonometry gives us the slope angle, which is typically derived for each grid cell in a DEM data by considering the local neighborhood at each cell. Solving for the maximum elevation change within the 3x3 block of grid cells surrounding the target cell gives us a magnitude and direction of slope for that cell—the magnitude being slope angle and the direction being slope aspect.

Errors in the DEM and the ability of the DEM resolution to capture the terrain variations can combine to compound errors in slope angle estimation.

At this point DEM errors and limitations start to come into play. Errors in the DEM and the ability of the DEM resolution to capture the terrain variations can combine to compound errors in slope angle estimation. Thus there are two primary sources of error when producing slope angles in DEMs: elevation errors in the DEM, and impacts of DEM resolution. With resolution, we are concerned with the size of each grid cell compared to how rough the terrain is. If the terrain changes elevation substantially over, for example, 5 meters of distance, but our DEM can only capture values every 30 meters, then a lot can happen on the terrain between elevation measurements.

The profiles in Figure 2 illustrate these resolution effects. If we calculate slopes between the grid cell centers (red lines) it is clear where slope angles are underestimated, and the peaks and valleys get clipped. Some of that detail can be estimated by doing a better interpolation (making curves instead of straight lines), but that is effectively an informed guess, with unquantified impacts on slope angle accuracy.

A look at overall statistics of elevation and slope across a DEM at different grid resolutions shows that the average values for elevation and slope don't change much with a coarser grid, but the max and min elevations get smoothed off. And most importantly, the maximum detectable slope angle decreases dramatically. THIS IS IMPORTANT—*with coarser elevation models, our ability to detect and map steeper slopes goes away.*

The perspective views of two different DEMs and their respective slope angle maps in Figure 3 demonstrate the comparative level of detail and in the steepness of individual terrain features.

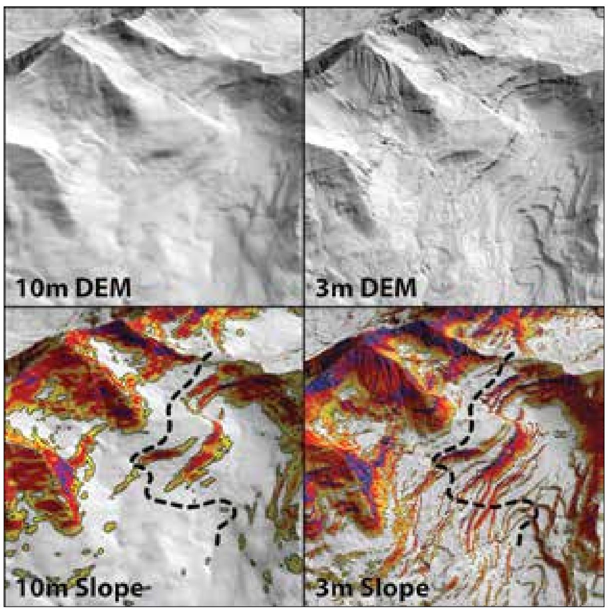

Figure 3: Perspective hillshade views of 10m (top left) and 3m (top right) DEMs, and slope maps derived from each in the lower panels. The different levels of terrain detail captured is readily apparent, and the slope angles calculated from the finer-scale grid are substantially steeper.

wind slab layers
thick as Van Gogh
brush stroke

It is clear that even with this relatively small resolution change from the 10m USGS DEM to a 3m lidar DEM, there is a dramatic difference in the ability to capture the slope steepness, as well as smaller terrain features.

Imagine that we are using the 10m data set to plan a route (dotted line). Ignoring for a moment whether it is a good idea to travel under all of the potential overhead hazard, the route itself attempts to exploit lower-angle ramps in the terrain to gain the ridge—at least according to the 10m data. Plotting the same line on the higher-resolution map, suddenly the route is crossing a bunch of short, steep, slopes that are not evident in the coarser data set. In some terrain, features like this might be easily avoidable by the alert routefinder, but in other terrain intricate route planning may result in unwitting commitment to avalanche hazard exposure.

Even though a higher resolution model tends to be a more accurate representation of the terrain, we can still use a coarser data set as a guide and tool for planning and navigating. The key is understanding how and where elevation model information can be incomplete: in complex or forested terrain, on features close in size or smaller than the DEM resolution, and in steeper areas. This description sounds a lot like terrain traps, and also describes small features that can be trigger points, or areas that may look like islands of safety but are not in actuality. By adding safety margin to accommodate these uncertainties, we can use the valuable information present in the DEM without inadvertently increasing exposure.

CONVERGING ON BEST PRACTICES

To summarize the primary ways in which digital terrain models can fail us:

- Small terrain features are often not captured by DEM
- Errors in DEM could omit, create, or mis-represent the size and shape of terrain features, due to forest cover, steeper slopes, & complex terrain
- Digital slope angle is likely low-biased

In addition to these issues, the digital tools in common use struggle to communicate the level of uncertainty in the underlying data—partly due to the nature of digital tools in general (not specifically the data they use)—in that there is an implied or assumed accuracy in the digital format that can be misleading. The fixed scale of paper maps allows an intuitive sense of distance and the size of terrain features, however the rapid scale changes possible with digital maps foster a dependence on the tool, and provide no corresponding visual cue that the accuracy may not support use of the data at that scale.

Further, our decision-making process must allow for compounding & interacting errors. For example, in addition to terrain model and slope angle errors, there is uncertainty in GPS positioning and therefore in our knowledge of our location in the terrain. Encountering these uncertainties when fatigued, in white-out conditions, or with a less-skilled or injured partner can pose serious problems.

Putting this information into practice, use of digital terrain tools can fit right into our existing uncertainty paradigm in evaluating avalanche danger and traveling safely. Knowing how digital data are produced can inform their use & weak points. In our route planning & decision-making processes, we can treat terrain analysis in the same manner that we treat stability assessment—acknowledging inherent uncertainties, leading us to incorporate wider margin into our route planning process. For example, narrow, lower-angle gaps in the slope angle shading may be enticing, but those features may not exist, and they may be connected to surrounding, steeper slopes.

On the positive side, digital terrain data and planning tools provide a wealth of information to exploit. Regardless of the specific slope angle accuracy, the presence of overhead hazard can be anticipated. Often, an indication of the relative terrain steepness can be extremely useful—focusing on mellower or steeper rather than the specific slope angle. Mapping apps can add photos showing forest density or rock outcrops, which can be just as important for travel as the terrain itself. While micro-routefinding requires constant field awareness rather than app-dependence, macro-scale planning is greatly aided by digital tools.

As with stability assessment, we can plan our route, then continually re-assess and be nimble enough to alter that plan when what we observe on the ground doesn't match our expectations. While looking for signs of instability, we should simultaneously be evaluating terrain features with a keen eye and our trusty inclinometer, recognizing in the same uncertainty context that the expected snow structure and the expected slope angles may be different than the forecast or our digital tools indicate. Our minds will tend to focus on what the visual tool shows, not what it doesn't show or what it implies. Active questioning is imperative to overcome this trap—does that narrow line on the map really distinguish safety from danger, or do we need more information?

By getting our heads out of our phones and actively looking for ways the terrain is different from what our digital planning suggested, we can reduce our likelihood of being surprised by the terrain.

Rules of Thumb are rarely appropriate in the avalanche world, but here's one that might keep us out of trouble: *it's probably steeper than the slope map says.*

Resources and Further Reading

US Geological Survey DEM product availability:

https://www.usgs.gov/core-science-systems/ngp/3dep/3dep-product-availability-maps

NASA Shuttle Radar Topography Mission

https://www2.jpl.nasa.gov/srtm/

ASTER Global DEM

https://asterweb.jpl.nasa.gov/gdem.asp

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SKIING ONE AT A TIME

What does it mean?

Originally published by WildSnow:
https://www.wildsnow.com/21313/skiing-one-at-time/#comment-89950

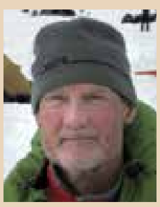
BY LOU DAWSON

Consider dating. Should you explore a relationship with one person, or play the field? How about your handheld. Do you layer multiple apps until the battery spurts flame and you get the latest version of electronic death? Or do you keep it simple, only a few things running at once? In either case, personal or digital, too many things at once might lead to easily avoided pain, or at least, suffering.

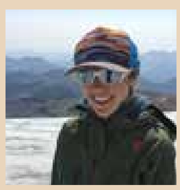
When it comes to "multiples," perhaps avalanche safety is an easier issue to parse than romance and phones. In my view, the gold standard in avy safety is exposing one person at a time to hazard, "OAT" for short. Funny how often the treasure is ignored. For reasons both bad and good.

On the one hand, "ski one at a time" makes perfect sense. On the other hand, any rule involving human nature interacting with natural forces can be sophomoric or perhaps even dated. For example, in the ancient past of extreme skiing we had a "rule" that said "climb it first." That adage could still save some lives. But steep powder skiing is now common, and climbing straight into the throat of a snow-loaded beast can be unwise, if not foolhardy. Likewise, many modern extreme ski routes are not practicable as climbs, even with firm snow conditions.

So, back to "ski one at a time." What does OAT really mean (besides the breakfast you hastily slurp as you race out the door to go skiing)? What are the pros, cons, and considerations related to skiing OAT?



WildSnow.com publisher emeritus and founder **Lou Dawson** has a 40+ year career in backcountry skiing and ski mountaineering. He was the first person in history to ski all 54 Colorado 14,000-foot peaks, has authored numerous books about backcountry skiing, and has skied from the summit of Denali.



Manasseh Franklin often found herself choosing between writing and skiing, which took her to San Francisco, the Tetons, and Laramie, Wyoming where she received an MFA in creative nonfiction writing and environment and natural resources. She now has happily merged the ski and writing life as the editor of WildSnow.

Top: Skiing down what you just climbed up requires good communication with the crew behind you. North aspect powder in the Ortler.

Bottom: Good thing it's a spring snowpack in the Ortler. OAT was evidently not a consideration here. *Photos Lynne Wolfe*

Molly Absolon on a big line in the Palisades of Wyoming. Finding a safe zone to regroup in this terrain means zigging back to the ridgeline. *Photo Lynne Wolfe*

Exploring the virtues of skiing

OAT

One At a Time

aaaaahhh, the turn,
I can smell it
in the air

OAT

1 It falls upon my keyboard to begin with a definition. In avalanche terrain, when a group agrees to ski a run "one at a time," the exact meaning is that only one person in the group, at any given moment, is exposed to avalanche danger (on the uphill or down.)

2 Item 1 above does *not* mean standing in the middle of a slide path, snapping photos of your buddy's face shots, thinking "if it slides, I'll just ski to the side…" Instead, OAT means each person runs out the entire pitch, one-hundred-percent, from one entirely safe zone to another.

3 Aha, "safe zones," or "islands of safety." What are they? Year after year, the reports roll in. Too often, skiers hang at what they perceive as an island of safety—and a big avalanche overruns their archipelago like a Class 5 hurricane. These tragic events show that identifying truly safe zones is as important as identifying avalanche slopes, and yes, it's the same thing.

The most common unsafe safe zone is the small island of trees you're "pretty sure is safe, because otherwise they wouldn't be there!?" Second to that, the side of the avalanche path—where did that myth come from? Also watch for the common noob mistake of simply not stopping far enough beyond the runout zone. See our alpha angle post for more about determining how far a slide can slide.

4 "But I watched a guide ski down with three clients at once!" Why? Most often money is the reason. While a group of three total is perhaps the ideal, the economic reality of guiding is that more than two clients per trip might be necessary. Separating a larger group and skiing OAT causes major time issues. Say you have a guided group of six, and skiing something OAT requires eight minutes each (hey, the clients are not auditioning for Matchstick). Just that one section adds an hour to the day! Guide tries to do OAT, clients enjoy happy hour in snow cave.

5 Cons to OAT? The biggie: Consider a nautical analogy. Man overboard. Your throw rope isn't long enough, no rescue swimmers are in the water, and you're too tired to dive. Shift the thought experiment to ski touring. You're on a 2,000 vertical foot run that you ski top-to-bottom OAT, the last person down is injured, or caught in a slide that doesn't run full path. You are exhausted, weather is looming, sunset is dropping like a theater curtain. Apply skins, climb, hope your headlamp has fresh batteries and the InReach is working.

6 Excuses to avoid OAT are many. Some in the nature of heuristics, some involving group dynamics, some just plain whacked: "I took a Level 3 course and I tell you this will never slide," or "We don't have time," or "Bill isn't a good skier, someone should pair up with him," or "Come-on, just once let's gang ski and make a video," or "To save time, just count to 30 then launch after me." And then what might be the clear winner of the Darwin award: "We all have airbags!"

7 And, worthy of its own spot on the listicle, we have no-OAT excuse number 672: "We have radios and we ski REALLY FAST." That's like a barn cat scattering a family of mice. At least one is sacrificed to appease the feline predator. Works with cats I guess. Avalanches just keep rolling—they hunger not for meat, but for souls.

8 How do dogs change the picture? To avoid incurring the wrath of our valued pet owning readers, please ladies and gentleman, have at it in the comments. If you're OAT skiing with the care of a pathology lab technician, how does Fido the Wonder Dog fit in?

9 This is where I get to equivocate. Yes Sir, there are times in the grumpy old mountains when they want you to move, get out, charge home fast, because: the snow is warming so it's better to get everybody off the slope NOW; rockfall is due to increase because of sun hit; you can see the blank wall of a whiteout headed your way like an apocalyptic desert sandstorm. Fill in the blank. (At least for some of us, isn't figuring this stuff out part of the appeal?)

10 To sum up:

- OAT is not a made-up rule that curmudgeons spout off to ruin the fun, it is real.
- Smaller groups might be the most important key to skiing one-at-a-time.
- If you ski with a guide who does not OAT, watch out for your own behind. You should be comfortable the guide has a darn good reason for keeping everyone in lockstep.
- Beware group dynamics such as the expert halo: "Dude, this thing could never slide!"
- Safe zones and islands need to be 100% reliable.
- Consider skier skills and gear issues. Stronger skiers go last to help the less fortunate who might be stranded in the middle of your big mountain descent.

LISA VAN SCIVER

A good article to bring to light and like so many safety techniques, a lost art at times. I'd think it would be important to use the OAT technique as often as possible, so when it is necessary the practice has already been established. In any mountain travel, it is important to recognize your hazards and then keep this process dynamic as they may change or be different than originally perceived. The terrain is the only constant and the avalanche problem varies, changing how that terrain be accessed or skied. A safe spot one day may not be an option another day, so as the avalanche hazard increases, the use of the terrain will have to change. Consider low angle terrain, which cannot avalanche, but on a super deep powder day, the concern becomes snow immersion.

Just as an avalanche forecast gives recommended travel advice, we as users need to apply that travel advice to the areas we plan to ski. One at a time does not mean it's then okay to be on slopes we think could slide. Even more importantly, we need to set ourselves up for the potential unknowns- a common theme with snow. Yes, there is a time when we know the snowpack is stable, but that understanding typically occurs after many months of analysis and monitoring.

The question I have is not so much how do we manage our own groups in the mountains, but how do manage ourselves around other groups? The skier and rider traffic in the backcountry is ever-growing; how do we develop a culture where we respectfully travel through avalanche terrain with other group's safety in mind. I feel this is especially the case in easily accessed slopes like around ski areas and on mountain roads. The powder frenzy drives people to ignore safe practices and not only put themselves at risk but also put others at risk. This is where I feel the OAT protocol could grow and keep us from causing fatal avalanches.

After ski patrolling with the Jackson Hole Ski Patrol for 10 years, Lisa Van Sciver has moved into a new Grand Teton National Park Foundation –funded position where she assists Grand Teton National Park and the Bridger-Teton Avalanche Center with operations and forecasts.

RON JOHNSON

Exposing only one person in the group, at any given moment, to avalanche danger is an excellent way to eliminate the avalanche hazard to the folks tucked away in solid no danger areas. It also affords the person exposed to the avalanche danger a better chance surviving being caught in an avalanche. But, it may not be the best option for dealing with the overall hazard associated with the specific circumstances experienced by that group, at any given moment, separate from the avalanche danger. Therefore, the decision to not go OAT must mean there is less overall risk to the group given their specific circumstances. It should be a tough decision to forgo OAT, but sometimes it may be prudent.

All efforts by your group to go OAT are for naught when another group jumps in above you. Being "ambushed" by another group needs to be considered when managing the avalanche hazard.

During the summer, Ron Johnson is a climbing ranger at Grand Teton National Park. Winter finds him working as an avalanche forecaster at Sylvan Pass in Yellowstone National Park.

AARON DIAMOND

Point 3: I'd argue an experienced backcountry skier can and often times should be able to identify safe zones not only in absolutes but also situationally. If we don't have a snowpack capable of producing a bibilical avalanche, shouldn't our travel habits reflect that and allow for adjustments to mitigate other mountain hazards? I could go on and on with this one and although I'm playing the confidence card there's a very good argument against it with a history of accidents to back it up.

Point 4: I can't speak for the mechanized guides but I don't gang ski for money or time reasons. Mostly it's to keep track of folks in broken or complex terrain and to allow them to rest their legs. I'd bet there's a lot more accidents in guiding from tired clients with twisted knees than avalanche involvements where people weren't skiing OAT.

Lou follows those first few points with good counter points in point 9. Again I'd argue experience allows folks to be a little more nuanced than not skiing OAT with less in your face hazards such as fatigue, route-finding, tree wells, micro terrain traps etc.

Point 10: " If you ski with a guide who does not OAT, watch out for your own behind. "

I'd rephrase this to "if you ski with a guide watch out for your own behind" How hazard is managed should involve input from the guest and feedback from the guide. Normally this is the guide's responsibility to initiate the conversation at the start of the day but a proactive guest can be great.

Aaron Diamond is a Teton-based avalanche instructor and AMGA Certified Splitboard Guide.

JED PORTER

- OAT is *a* "gold standard". I wouldn't say it is *the* gold standard in avy safety (emphasis mine.)
- OAT is a Damn Good Idea* for reducing the group consequences of a slide.
- *Damn Good Idea

noun /dam/ /good /idea/ *1.* A practice or habit that requires a damn good reason to not execute. As in "Backing up your rappel is a Damn Good Idea." or "Wearing a transceiver is a Damn Good Idea."

- You need a damn good reason to not ski OAT in avalanche terrain.
- It follows, though, that the reasons to not ski OAT are myriad and personal and situational.
- From the clinical, triage-like time management reasons all the way to:
- If "it is fun" is a good enough reason to go to the mountains in the first place, it's also a good enough reason, at times, to not ski one at a time in avalanche terrain.
- Speaking of fun and time management, it is totally possible to get an entire, large ski group all moving at once, with basic instructions, that put only one at a time in avalanche terrain. Terrain allowing, of course. Uphill or downhill, across or fall line. If the piece of avalanche terrain is small, and comms/group dynamics allow, first regroup on the near side of the avalanche terrain. Then make it abundantly clear to everyone where the far side of the avalanche terrain is (maybe the first person makes an "x" in the snow at the far boundary) and proceed OAT through without stopping immediately after the hazard. Regroup where and when it makes sense to do so. Keep an eye over your shoulder until the person or people immediately behind you are past the "x."

Jed Porter is a passionate adventure skier, mountain guide, AIARE course leader, in that order. All with an admittedly higher personal risk tolerance than the average peer in each of these roles. And all with a better understanding of others' risk tolerance than the average peer in each of these roles.

BLASE REARDON

OAT also preserves resources if your group does have an accident. It's much easier for two people to find one buried person than one person to find two.

However, I'm ever more aware how hard it is to achieve OAT consistently. It's particularly hard to find true safe zones in complex terrain with multiple start zones and undefined tracks and runouts. Tucking behind a few scraggly trees or a boulder isn't enough. I find myself stopping in spots that make me comfortable once I look around.

Blase Reardon is now known as "Silver Blase" in the Flathead avalanche community.

DALE ATKINS

Nice to see you're plugging in Lou's fulminations. His experience in the hills and on snow, along with his craft with words makes for great and valued reading. I like his message that OAT means skiing all the way out—100% of the time—is spot on. While I agree with his message, there are several points that motivate me to write.

- "Islands of safety" should be stricken from our lexicon. They are nothing more than an illusion, serving little more than a physiological shield. They don't exist. By way of a metaphor, Lou mentions the Category 5 hurricane, but all hurricanes—regardless of size—are dangerous and potentially deadly. When Dorian hit the US last September it had weakened to a Category 1 hurricane. Yet it still killed at least four people. (As a Category 5 monster Dorian claimed at least 65 lives in the Bahamas.) The same is true about avalanches; a small avalanche can be just as deadly as a large avalanche. Also, when people trigger avalanches, the slide is almost always much larger and way more powerful than expected. Just as hurricanes overrun islands, avalanches overrun "islands of safety" all the time. While we should never drop our guard, we should drop the phrase and drop the practice.
- I wonder if some readers will infer that groups get into trouble on longer runs. Run length has little to do with people's practice of OAT and who finds trouble. The reality is a lot of us are sloppy in how we manage people and terrain. If one looks only at how many people die per fatal avalanche, the stats show backcountry skiers seemingly doing a good job of limiting exposure. In the past 20 years, 118 backcountry skiers (not counting guided skiers, guides, students, or snowboarders) have died in 98 avalanches. (Ten other accidents killed two backcountry skiers each.) At face value, these numbers suggest that skiers are doing well, but there is more to the story.
- Dying in an avalanche is unlikely but there is no certainty as to who survives, either. Since there is uncertainty, we should consider the larger cohort of fatal and not-fatal accidents. Looking at a larger sample of 366 backcountry-skier avalanche incidents and accidents shows that 36% of the events involved more than 1 backcountry skier caught. Five percent of accidents caught more than three skiers. In reality, backcountry skiers are not good at what they have been taught.

20 years of US backcountry skiers caught/avalanches, 2000 to 2019 (Dale's records)

group size	number of accidents	%.%	median vertical fall (ft)	mean vertical fall (ft)	max vertical fall (ft)	min vertical fall (ft)
>5	5	1.40%	700	725	1000	500
5	4	1.10%	600	685	1240	300
4	10	2.70%	800	860	1200	500
3	31	8.50%	600	644	1800	100
2	81	22.10%	600	885	4000	50
1	235	64.20%	500	670	3500	30
total (all)	366	100.00%	500	1000	4000	30

- I have to confess; the statistic—36%—makes the point that "a lot" of groups of skiers get caught, but is it really that great? Probably not because of something called denominator blindness. We have no idea how many "accidents/incidents" (the denominator) occur, but we do know the number is likely very underreported. However, I still stand by my postulation that we are not good at practicing what we have been taught. If we double the number of single-skier avalanche events, the statistic for groups caught dips to 28%. Even tripling the number still means that nearly 1 in 5 skier-accidents/incidents caught more than one skier. Hmm…maybe where're not as good as we think we are.
- Back to run length, in the above numbers there is a trend for bigger groups to be caught in longer running avalanches, which I am extrapolating to mean the skiers were tackling taller terrain and longer slopes. Managing skiers on longer runs is a challenge, but if skiers can't do it non-stop, or if they're so concerned about the potential for the slope to slide, you probably shouldn't be on that slope on that day. Again, I argue that size doesn't matter. A lot of shorter slopes bring grief to groups. If considering the vertical fall for all groups (2 or more skiers caught) the median vertical is only 500 vertical feet. That's not a long run!
- Lastly, we often think of avalanche casualties being only those killed; however, those injured are casualties too, and more accidents involve injuries (minor to life-threatening) than deaths. Not practicing OAT can still ruin a backcountry day or seriously change one's future, even if no one dies.

Thank you for bringing Lou into our conversations. Like the TV commercial says, he knows a thing or two because he's seen (and even lived through) a thing or two.

As a long-time rescue professional, Dale Atkins is always a great source for insight and statistics.

JOE STOCK

Very cool assignment! Thank you for including me. Here are some thoughts:

Amazing article! I agree with everything that Lou wrote. Around Anchorage it feels like spreading out is often more appropriate than OAT. The backcountry ski terrain around Anchorage is mostly avalanche terrain with few safe zones. We call it The Sunburst Problem. Sunburst is a very popular roadside ski slope where most of the ascent is avalanche terrain, most of the descent is avalanche terrain, and the safe zones are imaginary. Rather than OAT, we go when avalanche conditions are acceptable for avalanche terrain, we try to spread out on the ascent, we ski OAT on the descent, and move as far away from the slope to stop, acknowledging there's no true safe zone at the base. The Sunburst Problem seems true for much of the Alaska backcountry where OAT means skiing solo.

I like Lou's discussion of so called safe zones. Around Anchorage, if feels like the only true safe zones are on the ridge or back in your car with the doors locked. We may think we've found a safe zone, but our mental database of how big a slope can avalanche is tiny, even if we've skied there 40 days a year for the past 20 years. We all struggle with this insensitivity to sample size bias. (From my favorite blog: https://fs.blog/2013/05/mental-model-bias-from-insensitivity-to-sample-size/). We're made to believe that terrain is the one backcountry variable we can control, but that concept feels like a farce around Anchorage. My friend Henry calls this terrain uncertainty. What we can do is to ski when conditions are acceptable for avalanche terrain, spread out, and stop way further from the runout than our intuition tells us.

Joe Stock is an Anchorage, Alaska-based IFMGA Mountain Guide with a passion for adventure skiing and traveling with his wife Cathy.

LYNNE WOLFE

I am really enjoying this conversation. Nice job, Lou, getting us started with an excellent and appropriate set of guidelines.

I've been known to tell a student that where he stopped was an "imaginary safe zone." Ha ha he never forgot that.

Also helpful in this list might be the concept of "leap-frogging," where we tuck one observer, ideally with a radio, in a place that can hold one and has good visuals both up and downslope, and have everyone ski "through" or past them all the way beyond the end of the shot.

Finding a safe zone is an art, not a science. I try to always ask myself, soon after skiing it, "was that the right place to stop for this path and this avalanche problem?" Even if I say YES, it's a productive query.

HENRY MUNTER

Thanks for the chance to do some hard thinking about this. In the guide room at CPG we have always wrestled with actual applications of OAT and I don't expect there to be any real end to the practical challenges given by the terrain we use. I'll give you my thoughts on theory and then add a couple tips that I hope will be more interesting and useful. [Hoping to stay between the double yellow lines of overconfidence and the white line of equivocation…]

On the theory level, one-at-a-time is a great rule for terrain management. It's only a perfect rule in perfect terrain: such as a run with a clean ridge, legit escape routes, a clean runout that isn't too flat, and that doesn't have any connected overhead exposure. For terrain not like that (most of it where I work), OAT works only as well as your ability to predict where the avalanche will run, if triggered. If you take an alpha angle approach—measuring the maximum possible runout—your prediction will be safe, but it will it take impossibly long to get anywhere with a group, and you will find yourself so far away from your partners that you are practically alone, safe from the very unlikely mega avalanche, but too slow to respond to the more likely small avalanche. If, on the other hand, you try to predict accurately what avalanche size and character threaten you and to predict where those avalanches might run, you're in the uncertainty zone. There, mistakes will be made but you may or may not know you've made them. If we're out in backcountry avalanche terrain to ski, chances are we're going to be accepting the inherent risks of the latter approach.

A lot of terrain simply doesn't allow for perfect one-at-a-time travel. In the that world, OAT is still sacred but needs to be supported by both tactics and luck. One practical tip for those situations: pay attention to the first person and the last person. The first person on the slope is going to have some thoughts about the snowpack. They're going to have a fresh perspective about where to regroup. They might find that they can't see well enough from where they stopped or that they don't feel safe there. Make sure the first person has all this in their head and that they have a way to communicate changes of plan. If you're skiing in unfamiliar terrain, you're very likely to find the terrain and snow looking and feeling different from "down there", and the first person to ski is the one who might need to adjust course as a result.

The last skier is usually the most exposed from a rescue-time standpoint and should ski a disciplined line. Try not to let CATHY (Cold, Afraid, Tired, Hungry or Young person) go last either, nor the person who is having issues with her binding or has to carry his dog. Think every time about how you would rescue that last person on slope and talk it out if you don't know.

I gave a talk on my theory of terrain uncertainty at the SAAW last year and included these photos. This run is a go-to during hazard and there's very few runs around here that are as manageable. The first picture was a skier-triggered D2 with no involvement, but was triggered by the fourth skier and the slide came uncomfortably close to the regroup. The second picture was a natural D3 that slid mid-storm on the same layer later in the season. That slide overran the common regroup spots but did spare one pickup. Obviously a lot more to the story here, but the point I was trying to make last year is that despite what we as practitioners think we know, we're probably not that good at predicting how far the bigger-than-D2 slides will run.

The other practical suggestion involves how you think. Throughout your travel in avalanche terrain think about how well you're achieving the goal of only exposing one person to an avalanche and keep an eye on it like you would watch the dashboard in your car. Talk and think honestly about how well you are achieving one-at-a-time. Unless you or someone else is really blowing it (or you are in easy-to-manage terrain) try to avoid putting it in binary, pass-fail terms. Finally, consistently take a step back and think about how your dashboard would look if you were reasonably wrong about the avalanche problem, and use that test to see how much of a buffer you should give to your predictions. Sometimes your predictions need a big buffer, sometimes they don't, but don't expect to know. Good luck sorting all this gook out, and thanks for doing the work.

Henry Munter is the General Manager and a Lead Helicopter Ski Guide at Chugach Powder Guides in Girdwood, Alaska.

STEVE CONGER

From Dale Gallagher's original teaching:

HOT CROSSING

High on the slope

One at a time

Take precautions

MARK SAURER

First off, thanks for directing us to this article, I had not read it. Since our late October winter storm has killed the MTB riding (for now anyway), it was good to review and think over our winter travel habits. In reading through the comments, it seems that many of us have similar habits (which is a good thing). As for my bulleted thoughts…

ON THE UP TRACK:

- when out as a work crew, we do tend to travel together, especially on the well established "trade route" skin tracks here in upper LCC. I've even overheard the comment, "here comes UDOT with their orange coats all in a row." (honestly, I think it was Hardesty who said that :)). In reality, we rarely are out in groups larger than 2 or 3.
- if, however, we don't like where the track is going, we won't hesitate to set our own across better (safer) terrain.
- when conditions or terrain warrant, we'll hold up while the first in line crosses something questionable, then proceed OAT across that zone.
- obviously it's common on a busy day here that several parties can be skiing above us towards a similar goal. If terrain they are crossing above seems questionable, then again we'll hold up in a "safe" spot and even consider a different route.
- when I'm traveling solo and breaking trail, for work or recreation, I just avoid putting my up track in or exposed to avalanche terrain.

ON THE WAY BACK DOWN:

- on a shorter run with good visibility, we certainly ski OAT to a predetermined safe gathering spot.
- if visibility is poor, we'll discuss route down before separating then make a radio call to whomever is waiting to go next so as not to ski on top of each other. Good chance to give beta about the snow conditions and best/most fun lines :)
- if the skier has an issue mid-track, he/she will communicate via radio so the others aren't wondering.
- on longer runs, we still travel OAT, but utilize "islands of safety" to leapfrog and keep the group a little closer together. These spots are discussed before we separate so we're all clear as to where each skier will be. Again, radio communication is key to assuring the first skier has pulled up and it's clear for the next to proceed.
- skiing solo, I take time to look around me above and below to be sure I'm not putting someone at risk or vice versa. I'll alter my route accordingly or just sit and wait if needed.

Hope that helps. Really no golden nuggets, seems like I generally agree with the article and comments. I do a lot of solo skiing up here at work and like to seek out the quieter areas to just meadow skip or bop through the low-angle trees. I leave the big, cool, rad, popular lines to the masses.

Mark Saurer is currently a highway forecaster with UDOT in Little Cottonwood Canyon and part time patroller for Park City. He's spent most of his professional life in the snow and avalanche world ever since he was hired on the Sun Valley Ski Patrol in 1987 as their youngest rookie ever.

EMILY JOHNSTON

A few thoughts in no particular order. (Not meant to tear Lou up at all, just thoughts on his thoughts):

1) "In my view, the gold standard in avy safety is exposing one person at a time to hazard, "OAT" for short." —LD

Although OAT is the gold standard, there may also be value in 'modified OAT' (TAT, 3AT, but probably not FAT). Blase Reardon's astute comment(from the online version): "OAT preserves resources if your group does have an accident. It's much easier for two people to find one buried person than one person to find two." With larger groups and lower hazard situations, in seeking the balance between efficient movement and hazard mitigation, could we risk saying: it's easier for six people to find two?

I'm personally averse to backcountry groups larger than 4-5, but both professionally and recreationally, larger conglomerations do happen so the logistics are worth pondering.

2) "Safe zones and islands need to be 100% reliable." —LD

Sounds great! We all know there is no "100% reliable" that we, as humans, can identify and confirm. Even general relativity breaks down at the quantum level.

"Hazard," "island of safety," "safe zone" are subjective and require good judgment to accurately identify. "Good judgment" is itself subjective. Are we good, or just lucky? And how do we know? Does good judgment come from training? experience? awareness? intelligence? divine intervention? alien abduction?…the answer is yes.

3) There is no checklist, or set of decision rules, that can replace good judgment, although they can be helpful tools. Checklists are used extensively in aviation and medicine, and have had a positive impact on safety. In medicine, there are many sets of decision rules, but research has shown that the decision-making of an experienced provider is still better than strictly following a set of rules. Decision rules are helpful guidelines for those who are still damp behind the ears, as well as crusty veterans, however, experienced intuition still trumps data. Also true in avy terrain. But what does "experienced" mean? See "good judgment" above (like a watermelon seed, or a dirtbag boyfriend…hard to pin down!).

"Finding a safe zone is an art, not a science." —Lynne Wolfe

Exactly!!!

4) "But I watched a guide ski down with three clients at once!"

A fine example of 'normalization of deviance' (amongst other things) which is its own, highly relevant, can of worms and perhaps deserves to be addressed separately.

5) During avalanche control work, OAT with closed loop communication is the norm. Why is this not the case in the backcountry? Self observation tells me that I operate differently in these two environments for a number of reasons; some conscious, some subconscious, none entirely logical. Clearly the goals are different. Also, control work usually happens when the avy danger is more significant; backcountry travel usually happens when the avy danger is less significant. Obviously, there's overlap in this Venn diagram.

One simple thought is that better communication capability and structure would be beneficial in recreational backcountry groups, but is expensive, logistically complex, and perhaps intrusive.

6) While it's important to dynamically assess the risk in your environment, and actively mitigate hazard, it's crucial to not get so focused on hazard assessment and mitigation techniques that you forget to ask yourself: If I think it's really this dangerous, what am I doing here in the first place? There is no shame in putting your tail between your legs and beating a hasty low hazard retreat.

Emily Johnston has been a pro patroller, mountain guide and backcountry skier for about 30 years, and occasionally takes time out from itinerant recreational work to practice emergency medicine.

PETER THURSTON

Great article from Lou. I have experienced most of the variations that Lou writes about. Here are some thoughts:

Of course the usuals like stability assessment, outcome assessment if things go wrong, safe spots, etc., all come into play but given a scenario with a nice long pitch deemed stable enough to ski (but still suspect) with good safe spots I have seen the following:

Real OAT—each person skis the entire run and parks at a safe spot before the next person proceeds or the group leapfrogs OAT between safe spots. This approach only seems to work with small groups (2–3) of people who ski (together) a lot, are patient and willing to take the extra time, are happy to alternate sharing the freshies and don't feel pressured to get in as much skiing as possible during the day. From a safety perspective this is clearly the best option and I personally love the leapfrogging approach. Most of my ski partners who are happy with this approach have witnessed substantial avalanches or seen slopes that avalanched on the second or third or fourth run. Having seen the beast in action they know what can happen.

We agreed "but" OAT—in this case the group agrees to go OAT but when the first skier is most of the way down and an avalanche has not happened one person will get itchy and just jump in. If the slope doesn't slide with skier #2 the positive reinforcement feeds the rest of the group and quite often OAT is then abandoned. This is super frustrating, especially after the group agreed to go OAT. Larger groups (3–6) of skiers seem to be at risk of this happening. Often these are folks who don't have the opportunity to get out as much as they would like and are keen to maximize the ski day. However, I've seen lots of super experienced people jump in and go like this. Presumably they've made some sort of revised assessment in their heads while watching the first skier and decided that OAT was not really necessary. If I'm in a group and this starts to happen I tend to hang back and go last.

I can't see you OAT—here we have the classic conundrum of skiing OAT but the skier vanishes, presumably into a safe spot, and the folks at the top don't know what is happening down there. This seems to happen a lot in unfamiliar terrain. Some folks are now carrying radios that can alleviate the problem a bit, but the root of the problem is communication (visual and audible) and finding a safe spot to stop where the folks at the top can still see you.

It can be really hard to stop where the rest of the crew can see you when you are skier #1, the snow is stable, and you are in full powder pig mode. The tough part about this scenario is what to do next. Skier #2 essentially now has the same risk as skier #1 with the added risk that #2 will trigger a slide that entrains skier #1. There's no easy way to mitigate this variation on OAT. Try really hard to make a safe spot stopping plan and stick with it. A predetermined "I'll holler twice when it's safe for you to come down" can work if everyone stays quiet and waits for the holler.

OAT not required—There are conditions where OAT is not strictly necessary. In this case the first run might be done OAT but subsequent runs on the same slope or new runs on similar aspects are skied as a group with adequate spacing between skiers. This is lots of fun, you're zooming down with your buddies, all hooting and smiling and contemplating more laps. I think this is everyone's favorite, certainly lots of fun for me, but it takes a tight (small) group with good assessment skills to "make the call." Good knowledge of the terrain also helps in making the call to ski as a group.

Strong skier last—In a group with skiers of mixed abilities I'm a big believer in this. More than once I've played sweep and had to help someone else get back together after a crash mid slope. I don't mind this at all and it seems to help the less strong skiers enjoy the experience if they know there is someone watching from above.

The photo stop—I'm 100% guilty of this one because I love to take photos. I am well aware that some of the "safe" spots I've chosen over the years were not really that safe so I do try to be more situationally aware. No easy answer to this one. Some days I have the camera but conditions are sketchy so the camera never comes out. Other days the stability is good and I have the opportunity. What I don't want is to get buried and die with my legacy being the last photo in the camera showing a wall of snow headed at me.

Safe spot in runout—Very common problem with folks who have never seen firsthand how far a slide can go. I've seen people waiting at the "safe spot" in the middle of the runout at the bottom of the run wondering why nobody else in the group has come down yet. If you're going to ski the entire shot OAT make sure that everyone agrees on where the safe spot is at the bottom before skier #1 heads down.

Finally, there is the **no go** option. There are times (not many fortunately) when you skin up, check it out, see all the signs of poor stability, don't like the snowpack at all and have to decide if you're going to ski something other than the skin track you just came up. Typically evolves (devolves?) into deliberations about no go versus "maybe if we're really careful and go OAT we can do it." This turns into a mind trap that pits you and your abilities against your best instincts and training. Being able to say no is really hard. A discussion of "just say no" could fill an entire article.

Peter is an avid skier and outdoor enthusiast based in Driggs. He recently retired after 35 years as a geologist and is now planning more ski adventures.

This scenic ski shot on the west side of the Tetons has a largely imaginary safe zone between the two parts of the pitch, probably best titled a "regrouping zone."
Photo Aaron Diamond

JOSH KLING

Never a never…First off, there is never a *never* and never an *always*, and always will always get you in trouble. Those are pretty solid words I live by and preach on all styles of programs. I have trouble when folks say "you should *always* do XXXXX," or "Never do YYY." That goes for OAT, air bags, goggles, whatever example you want to use.

Have a normal:

- I like to "Have a normal and then argue against it." Example is I *typically* like to ski with an air bag pack, skiing the majority of my time in the backcountry wearing one (Probably 90%+ of the time with one.) However, there are instances when I do not. Example might be skiing couloirs in May or June around Silverton when I am more concerned about rock fall than avalanches. OR a long multi-day ski tour where we are really avoiding avalanche terrain altogether.
- Regarding OAT, I typically *do* like to ski one at a time. This goes for a guiding context or when touring recreationally with buddies. The cost/ benefit seems to be well worth it. It costs minimal time and the benefit seems to be worth it, especially if I planned the rest of the tour well. That said, in some instances it's not needed. What if we are skiing low angle hippy pow (20 degrees) and not in a runout? Skiing "Waren Miller" style as a group can be super fun!

It's just a tool: OAT is just one tool in an entire tool box of risk mitigation. However, it may be one of the most useful tools out there.

Actually do it! If you are going to ski one at a time, then really do it.

Make sure they are *really* safe zones:

- Make sure safe zones are *really* safe zones. I was working with a new guide a number of years ago around Red Mountain Pass. She walked me though her thought process of how she was going to guide us down a particular run. She pointed out her safe zones and exits. She at least had a safe zone on her radar. However, like many, she was not really choosing appropriate / actual safe zones. We discussed how if the slope avalanched, her "safe zone" would still be taken out.
- She skied the runs and set the skier's right boundary. She had a great run. The second skier went and spooned her tracks. On his fifth turn the slope avalanched. The second skier was not caught, carried, and there was no loss of gear. The slide ran to his left. The first skier/ "guide" was in the *new* safe zone that she and I had agreed upon. She was untouched in her amended safe zone. Had she been in the original safe zone she would have been buried. It's not often that you get such clear and timely feedback.
- A mentor once told me that safe zones should "give you the warm and fuzzies." Folks seem too often underestimate how large avalanches are going to run. This seems to be true even when we have a reasonable and accurate understanding of the snowpack and avalanche problems. If you look at the safe zone and say "well, as *long* as this doesn't avalanche *THAT* big, we SHOULD be ok…" Then it probably is not a safe zone. ⬢

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These two pictures give some perspective. The first picture is looking back up from the new safe zone. The second picture shows the two skiers. The first "safe zone" was right in the middle of the debris pile. *Photos Josh Kling*

descending moon's
pale light—
new stellars

Ascending through the forests just below the Hörndl in Embach, Austria.

COURSES FOR CROATIA

CROATIAN MOUNTAIN RESCUE SERVICE TURNS TO THE U.S. FOR CONTINUING AVALANCHE EDUCATION

STORY AND PHOTOS BY SEAN ZIMMERMAN-WALL

IN FEBRUARY OF 2013, A SMALL TRAINING CONTINGENT OF SERVICEMEN FROM THE CROATIAN MOUNTAIN RESCUE SERVICE (HGSS) WERE CAUGHT IN A WET SLAB AVALANCHE ON THE REMOTE FLANKS OF KAMEŠNICA ALONG THE BORDER BETWEEN CROATIA AND BOSNIA AND HERZEGOVINA. ONE MEMBER WAS BURIED AND KILLED IN THE SIZE THREE AVALANCHE THAT RAN MORE THAN 1500 VERTICAL FEET AND CASCADED OVER A 200-FOOT CLIFF. THE REMAINING THREE MEN WERE ABLE TO EITHER SELF-ARREST OR WERE CAUGHT, CARRIED, AND INJURED. DUE TO THE ISOLATED LOCATION OF THE ACCIDENT, HELICOPTER OPERATIONS WERE LAUNCHED FROM THE HGSS BASE IN THE VILLAGE OF SPLIT. AFTER A SHORT DELAY FOLLOWING DEPLOYMENT, AN INTERNATIONAL AGREEMENT BETWEEN THE TWO COUNTRIES ALLOWED THE RESCUE TO TAKE CONTINUE WITH JOINT OPERATIONS. THE INITIAL RESCUE TEAM INTERCEPTED THE INJURED PARTIES AND BEGIN SEARCHING THE MASSIVE DEBRIS FIELD FOR THE MISSING TEAM MEMBER, WHO WAS NOT WEARING A BEACON.

Evacuation of the two seriously injured climbers took place before the mission was suspended due to inclement weather and darkness. The afternoon of the following day, a search party of over 200 people and an avalanche dog eventually located the victim's body. This represented the first organized deployment of the HGSS to an avalanche rescue. Additional investigation of the event followed, and it became a case study to draw from during the International Commission for Alpine Rescue (ICAR) congress held in Croatia later that year. Needless to say, the presentation caught the attention of many in the audience, including rescuers from the Snowbird Ski Patrol and Wasatch Backcountry Rescue. Many conversations and a few beers later, out of this tragedy a relationship was born that remains intact to this day.

The HGSS Ski and Avalanche Commission took the momentum generated from ICAR and worked to secure funding to continue training their members to a high standard of avalanche education. This allowed for a group of three senior HGSS members to travel to Utah in 2014 and participate in a week of training with the Snowbird Ski Patrol. Focusing primarily on snowpack and avalanche hazard analysis, the team learned the methods employed by forecasters working in Little Cottonwood Canyon. The success of this initial training garnered further support for the HGSS to build a greater knowledge base among its membership. Over the next several winters the HGSS performed its own trainings in the mountains of Croatia and portions of the eastern European Alps.

In spring of 2018, two more senior members of the HGSS traveled to Utah to participate in an AIARE PRO 1 course hosted at Snowbird. They were interested in seeing the new A3 training paradigm and to continue adding to their own skillsets. Beyond the subject matter of the course, the weather featured a notable rain event that fell on a deeply buried persistent weak layer. An ensuing avalanche cycle impressed upon the participants a lesson similar to that recounted during ICAR in 2013; wet avalanches are difficult to manage and can be incredibly destructive. Coming out of the training with newly gained perspective sparked further interest in avalanche study for the members of the HGSS. Plans were soon set in motion to send a U.S. instructor back across the pond to deliver training to a greater audience of the HGSS Ski and Avalanche Commission. After diligent discussion and careful logistical legwork, the stage was set for the next chapter of the relationship between Croatia and Snowbird.


The HGSS Crew at Schmittenhöhe Ski Resort, Austria.

Walking off the plane in Zagreb to 60-degree weather and flowering trees is a relief after a long journey. Having my baggage show up would be a greater relief. Learning my gear is sitting on a tarmac in Paris and that I am about to catch a ride across two countries is like getting off the tram on a powder day without skis. Fortunately, my Croatian colleagues greet me with a cold one and we load the vans for Austria. The gear will catch up eventually, I hope.

Meeting up with my hosts from HGSS Stanica Zagreb, I am in good hands and adventure bound. The next four hours consist of driving across the Croatian and Slovenian countryside as the sun sets over the Alps while acoustic guitar riffs calm my nerves. Traveling through immense mountains always seems to make other problems seem insignificant and I focus my attention toward learning the native tongue through folk songs and the occasional Guns and Roses cover. By midnight we are in the small village of Taxenbach, Austria, where we will base for the next week. After a traditional mountaineer's meal cooked in the Peka, a giant bell-shaped BBQ apparatus, it is off to bed. I have almost forgotten I don't have any ski gear.

Waking up to the clear skies and mild temps of mid-March, we combine my minimal kit with a hodgepodge of extra gear from the HGSS lockers in the basement of our lodge. Fortunately, these folks are well-equipped and eager to help out a fellow snow traveler. The first field session on this training is at the nearby ski resort of Rauris where we will engage in an Avalanche Rescue Course. Riding up the gondolas to 2,000 meters we can clearly see the most recent rain event has wrought havoc on the snowpack. A widespread wet slab cycle has torn through the Hohe Tauern and left devastation below 1,800 meters. Cornice fall has ripped out deep slabs and there is also evidence of glide avalanches across the range. The underlying grassy slopes in this area make glides a real threat like I have never experienced. We discuss this latest cycle and then find a clear patch of cold-ish snow to run through rescue scenarios.

It is clear that rescue is something in which this crew is extremely well-versed. They make light work of the single and multiple burial drills and interact seamlessly. We discuss how to deal with signal overlap and focus on some of the latest techniques in excavation. The fine weather makes life easy and I try to throw in some close proximity deep burials to keep them on their tips. By late afternoon everyone is soaked through and it's down to the base for après. The lower elevations have suffered even more greatly, and we praise the man-made strip that allows us to make it to the parking lot. The rookies fetch the van and we are quickly heading back for lectures on incident command systems employed around the world and avalanche scene management. Dinner arrives just as my ski gear shows up under the care of Nikola Brebric, Head of the HGSS Ski and Avalanche Commission. We lift our glasses in cheers to him and retire fully exhausted and delighted by the storm clouds rolling over the mountains.


The definitive avalanche paths adjacent to the Maurerkogel in Zell am See, Austria.

The next several days are punctuated by snowfall in the high country and minor accumulations at the lodge. Our focus turns to operational risk management, snowpack analysis, and hazard assessment. The all-volunteer HGSS is comprised of a wide array of professionals with a passion for the outdoors. Sitting around the room are mechanical, electrical, and civil engineers, business executives, craftsmen, dive masters, speleologists, and former special forces members. They draw from their collective experiences and disciplines to contribute to the organization; some have been with the HGSS for over 40 years. Listening to their backgrounds and their desires to pursue a life in the mountains further inspires confidence that this group is dedicated to providing great support to their country.

Beyond creating trained observers, one of the overt goals of this training is to provide a framework for the HGSS to start delivering public avalanche safety bulletins in those areas where avalanches are a threat. Developing avalanche awareness programs and educating their citizens about the dangers present in mountain travel will be another facet of their future plans. As Brebric puts it, "We do have avalanches in Croatia, but they're happening in remote mountain areas where there aren't many people, yet. With more of our citizens traveling to the nearby Alps, we have the potential to be a future exporter of avalanche victims in Europe."

A wet slab avalanche as result of cornice fall in Rauris, Austria.

WE DO HAVE AVALANCHES IN CROATIA, BUT THEY'RE HAPPENING IN REMOTE MOUNTAIN AREAS WHERE THERE AREN'T MANY PEOPLE, YET.

WITH MORE OF OUR CITIZENS TRAVELING TO THE NEARBY ALPS, WE HAVE THE POTENTIAL TO BE A FUTURE EXPORTER OF AVALANCHE VICTIMS IN EUROPE.

With these goals in mind, we carry on from theory to practice and head into the countryside for a ski tour above Embach. Taking off from the end of the town's highest road, we travel up logging cuts and old service routes to a small peak called Hörndl, just above 1600 meters. The low elevation gives us the opportunity to see just how saturated the snowpack was prior to the 30 centimeters overnight. Gathering snowpack observations and practicing group management skills becomes our main task, and we find decent spongy skiing along the way. By sunset we are pulling up to the old cathedral at the end of the road.

Over the next two days we run through operational meetings and the finer points of ISO 31000. For our field venue we visit Schmittenhöhe Ski Resort above the town of Zell am See. Our local resource and Croatian ex-pat, Marek, leads us from the upper mountain and into the shadow of the Maurerkogel, just above 2000 meters. We spend time gathering avalanche observations from the still visible wet cycle and how the latest snow is bonding at higher elevations. This transition from near treeline to alpine provides a great opportunity to see firsthand how the snowpack varies quickly across terrain and how to make the most out of fieldwork with small groups. The teams quickly determine the structure from aspect to aspect and move through the landscape working on their team dynamics. Including navigating us to a nearby refuge called the Pinzgauer Hütte for some regional craft delicacies. It's not all work you know.

On our second-to-last night we decide to visit a former ski hill that has been turned into a Randonnée specific venue for the working-class crowd who just wants some exercise. Traveling up the frozen piste towards the low elevation summit, we use headlamps until the full moon rises over the main spine of the Alps in the distance. Arriving at the Enzian Hütte by 9 pm, we shed our skis and stop in for dinner. This remote hut only serves the intrepid crowd willing to walk for their meal. It becomes an excellent venue to take in the true Austrian culture and mix it with some Croatian flavor. The weary legs disappear with each pint and we are happy it's a nice cruiser back to the vans. By midnight we are back in the lodge, ready to rest up and meet the final day of the training.

The infrastructure of the Alps supports quick access to the highest peaks of the area. Gondolas and tram ways transect the landscape, connecting entire valleys to one another and providing opportunity to reach incredible terrain in the blink of an eye. This leads to a more pronounced "Freedom of the Hills" cultural thread, which undoubtedly contributes to the staggering number of avalanche fatalities compared to the meticulously controlled environment of North America. From our lodge, we are on top of the glacier at Kitzsteinhorn Ski Resort in about 30 minutes. The team identifies the wind slab and wet loose problems, with an objective to cover all aspects today and verify the present hazard. We also discuss the importance of understanding snow surface transformation and how it relates to ski quality variation across terrain. This is my favorite part.

The afternoon comes quickly, and our team sets up the perfect alpine picnic overlooking the Alps. Austria's highest peak, the Grossglockner, stands glistening on the southern horizon. Out comes the charcuterie and all that's missing is a bottle of wine. Sometimes it is work you know.

Following a brief discussion on the finer points of Bavarian dried meats, it's skis on for a lovely descent on a glacial ramp. Team management and setting appropriate safety margins for a group this large requires some thoughtful discussion. One of the more senior members sets a boundary track and we all follow suit, blissfully skiing recrystallized powder for a few hundred meters. The former Head of the Ski and Avalanche Commission, Branko Šeparovic, carves perfect tele turns down to our position. His 70 years of mountain experience shine through as he performs better than teammates half his age. The smile on his face reminds us just how important this kind of training is. We all want to be that old man in the mountains.

This experience comes to an end with one last barbeque and a thoughtful course close from the group leaders. Brebric conveys the immediate goals of the team and how they will need to continue to refine the skills they have just learned. "The HGSS has an extra high quality of service and excellent perception in the public, and we will continue to educate all of our members in avalanche safety."

Taking their knowledge and addressing public safety issues in Croatia will be the next step. The challenges are many, but the team is well prepared to address the situation and find creative solutions. Stay tuned and learn more about the work of this group at www.gss.hr.

Harvesting the cold dry at Kitzsteinhorn Ski Resort, Austria.

HUCKEM

Real World Avalanche Risk Communication

"To acronyms and beyond!"

BY STEVE CONGER

I want you to picture yourself sitting in a row of winter enthusiasts listening intently in an avalanche awareness class or a continuing professional development course. Look left in your row and look right in your row. It'd be pretty easy to go ski touring with one person that's sitting next to you. You know them. Take a look and think about their qualifications. You know how good you're going to feel getting out there and how easy it will be to communicate. Now look at your whole row. You're out there skiing in that big group, with a really big set of qualifications and experience along with what you know about each person. Are you going to have a morning meeting before you go out? How is the tour going to unfold?

This exact situation occurred in January 2019 when a group of eight planned a ski tour where they were very familiar with both the terrain and each other. The planning consisted of "We're doing the Z circuit, who's going?" Nearly every letter in the acronym FACETS (Familiarity, Acceptance, Consistency, Expert halo, Tracks / scarcity, Social facilitation[1]) came in play on that day. The group splintered in the field with everyone still going the same way, just spread out a bit and not traveling cohesively. The group converged at the base of the crux. There was some conversation before going up the slope (e.g. sharing of pit results and some other info); however, the decision-making was tacit vs explicit. More importantly, not all group members expressed doubts or concerns. The decision to go was more or less finalized by one person taking the lead with no discussion of best route up etc.). The decision to go one at a time (a good one) was essentially from experience vs discussion. The feature was visually homogeneous, however, as the trailbreaker shuffled from the steeper slope at the convexity; a thin spot where the wind slab had been scoured a slab released at the tail of the leader's skis. The ensuing slab was two meters deep on climber's left (the side where the group was waiting below) and a meter deep on the right (a healthy D2.5 that could have been a D3 with a real track rather than a profile like a hockey stick) and covered part of the approach track.

This commentary expands on "acceptable uncertainty" described in earlier articles[2]. In summary, during avalanche risk management, first we acknowledge uncertainty's presence, and then reduce it by changing the hazard with explosives, changing one's exposure in space and or time, changing the objective to one unaffected by the uncertainties. The final steps include communicating the irreducible uncertainty and embedding it in decisions. This is where the personally applied risk assessment question of "Is the uncertainty acceptable?" comes to play. It is the final filter before acting. Asking the question as part of on-site decisions will help limit treacherous biases associated with the affect heuristic. It goes a long way towards removing the ego and emotion from the decision process.

So how do you start the conversation with the people in your row when you are out ski touring? Can this all too common group dynamic be alleviated in a manner that leads to better backcountry decisions?

A survey of recent literature revealed a suggestion by Swiss researcher, Benjamin Zweifel. He outlined the parameters for a group process and decision check tool at ISSW 2014 stating: "…such a tool has to be simple enough to be practicable in real life situations with limited time and limited capacity of individuals…[3]" He utilized an acronym to provide a mnemonic for a six-element guidance matrix. Though not ideal for facilitating field discussion, it is an excellent instructional tool for recreationalists learning a framework to assemble and operate as a group.

For the all too common situation that described in the opening paragraph, a group check tool must be **friendly**, **effective**, and **memorable**.

HUCKEM is a prompt, a stimulus for a structured discussion in an informal moment. It can be employed by novice and expert alike. It is a holistic way to address what Roger Atkins suggested when he wrote about how it is important to create motivational bias towards actions that fit the situation. It captures the axiom that increased uncertainty increases risk.

Though each letter represents a word that we could spend a lot of time talking about individually, they combine into three two-letter concepts: Hazard Uncertainty, Collaborative Knowledge, and Exchanged Mindset.

Hazard Uncertainty elicits thought to what component of hazard has the most uncertainty associated with it. We have an extremely useful framework in the Conceptual Model of Avalanche Hazard[4] that segregates key contributory components; problem type, location, likelihood of triggering, spatial distribution, and destructive size. There are inherent uncertainties associated with many of the different value descriptors used in the conceptual model. Identifying which component of the hazard has higher uncertainty helps keep the perspective focused on where there needs to be the largest **margin for error**. HU is a prompt for quick focus

Top: Decision made. Just another ski day off the shoulder of Iconoclast Mountain, Selkirk Mountains, BC. *Photo Paul Karchut*
Bottom: January 2018 avalanche described in the article. The left photo was taken is moments after the release behind the leader's uptrack. *Photo Saul Greenburg*

and prioritization whether sensitivity, distribution, problem type, size, or location has higher uncertainty. Nothing new here, when one is unsure about hazard, one chooses to dramatically reduce or nullify exposure within or to terrain that potentially harbors the hazardous conditions in a manner that avoids consequence if it's more sensitive, widespread, or larger than expected.

Test results that are reactive or *unreactive* are on a similar level of uncertainty theoretically. When conditions or results are *touchy*, uncertainty is typically much lower. *Stubborn* (and planar) test results leave the observer with the highest uncertainty.

The spatial density and distribution of an avalanche problem and ease of finding evidence (spatial distribution) often contributes to hazard uncertainty. Increased uncertainty may be present when evidence is rare and hard to find, e.g. *isolated*.

Some avalanche problems are associated with higher hazard uncertainty than others. The hazard uncertainty often increases as expected destructive size increases.

Some avalanche problems are associated with higher hazard uncertainty than others. The hazard uncertainty often increases as expected destructive size increases (e.g. 30 cm versus 50 cm persistent slab or "what may lead to release in that 75 cm storm slab?")

Collaborative Knowledge ties the HU to the EM. Collaborative knowledge means the expectation that everyone in the group contribute in the hazard discussion and mindset exchange. This does not have to be elaborate, just a quick expression using a Concise, Logical, Explicit, Ambiguity-free, and Resonating (CLEAR[5]) style of communication. Collaborative decisions are a core of the Canadian avalanche risk management framework. One finds them in our operational meeting format, our terrain coding guidelines, and our workplace expectations. Collaborative decisions are consistently better than individual one. No individual is given the expert halo; no one individual sets the objective.

Exchanged Mindset completes the picture, a necessary conclusion to the process. The concept of an avalanche strategic mindset[6] has permeated our culture thanks to its practicality and relevance as a shorthand method to communicate. Exchanged mindset means each individual state their current strategic mindset using either the operational or the recreational model[7] (e.g. open season versus freeride). Exchanging mindsets is a great way to understand what perspective an individual is viewing the situation. It ensures an acknowledgment and or clarification of each other's ideas on moving forward. Simply put, we cannot huckem as a group unless everyone is on the same page. Embedded in the standardized list of mindsets is an anticipated risk management strategy.

There are just the three points (HU-CK-EM) to drive a quick, explicit, and systematic discussion amongst peers. To keep it effective, we do not want to stand around for any noticeable amount of time. Try it. Just look down your row, side up to your partner, pause at key decision points, and friendly ask, "Dude, can we HUCKEM?" Returning to the January 2019 ski touring situation, any one of the group could have asked it over breakfast and anyone could have asked it to refocus the group at the crux.

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Lazy BRAIN

What We, as Backcountry Users, Can Learn from Clinical Psychology

BY SARA BOILEN

Your brain is lazy. It seeks shortcuts and ignores information deemed irrelevant to the tasks at hand. This is the only way it can manage the massive amount of input possible in any given moment. In his seminal piece Evidence of heuristic traps in recreational avalanche accidents. McCammon (2002) introduced the backcountry world to the concept of heuristic traps, and F.A.C.E.T.S. provided us with an excellent foundational understanding of some of the key thinking errors we all fall victim to. However, as our knowledge of snow mechanics has continually evolved since 2002, so too should our understanding of human behavior. Let this article serve as a primer for some of the many theories of clinical and experimental psychology that may offer us insight into our own behaviors, which can then enhance our educational platforms for our students, not to mention improve our own touring practices.

Heuristics are the mental shortcuts that allow our brains to quickly and efficiently make sense of the complex world we must navigate. These rules or guidelines aid in learning or decision-making. Unfortunately, because our brains are so lazy, they often permit the heuristics do their work for them. For example, when you approach a stop sign on your way to work, you don't think "that sign is red and says, 'stop' and I should pause here to look for oncoming traffic before proceeding through the intersection." You just stop. If we considered any and all incoming data, we would never get anywhere, especially if the patterns stay the same (which way do you drive to work or to your child's school EVERY day?) And heuristics, while often expeditious, are not always effective in managing this reality, especially as patterns change. Heuristic traps, you might say, have a way of leading us into terrain traps.

Confirmation bias, first proposed by Daniel Gilbert, postulates that individuals seek out information in our environment to corroborate our suspicions (or beliefs). We may ignore crucial bits of information (i.e. sudden weather changes) in support of maintaining our original beliefs. If I decide my partner is acting like a jerk, I am likely to interpret his tone and words to verify my story. In short, our lazy brains select information from the world to prove us right.

In the backcountry, confirmation bias is equivalent to wearing a pair of blinders that only permit you to see your objective. Let's say you've decided to ski a particular line. You gather a solid crew, gear up, and head out. The forecast called for some heavy snowfall that day and your avalanche bulletin had both considerable and moderate ratings. Depending on your confidence

newly fallen snow,
fresh
signatures

(and, for the purpose of this article, let's say you're quite confident), you have the potential to skew incoming information in favor of your belief that the line will go. You may neglect to realize how fast the snow is accumulating and you may ignore your partner when they suggest they heard a whumph (seriously, I have denied this myself), and you may even disregard bullseye information through a series of unconscious, harmful mental gymnastics moves that verify your belief that it will go. Anyone who has ever had a fight with a romantic partner or a that nutty uncle at Thanksgiving knows that when someone has their mind made up about something they believe to be so, it can be difficult, if not impossible, to talk them out of it. Confirmation bias—the stubborn side of your lazy brain.

Confirmation bias likes to team up with its friend, **first impressions**, to co-create other nasty brain traps. First impressions, we all know, are important in job interviews and first dates. They are also highly relevant in the backcountry. First impressions often rely on a psychological phenomenon called **anchoring** in which the first bit of information we gather serves as a reference point for all new information.

Two winters ago, northwest Montana was getting hammered with some amazing snow and we were loving it. I planned to meet a couple of friends at a coffee shop at the mouth of the canyon where we would tour that day. There, there were several other groups, doing the same. When the clock struck seven am, an acquaintance turned to me (I was holding my cell phone) and asked, "Can you pull up the forecast?" I clicked through to the Flathead Avalanche's bulletin and—smiling —held my phone up to the ten or so backcountry users to reveal a big swath of green superimposed on our forecast region. Since this was, presumably, one of the first bits of data the recreators were receiving about the snowpack that day, I had just provided their brains with a solid anchor (for better or worse). As a psychologist, who studies this stuff regularly, you would think I would know better, but my stoke is no different from your stoke and my brain is just as lazy.

Solomon, Greenberg, and Pyszczynski (2015) in their book *The Worm at the Core: On the Role of Death in Life*, proposed **Terror Management Theory**, which surmises that anxiety of death motivates us to embed ourselves in cultural worldviews that buffer us from the reality of our impending doom. A relevant aspect of the theory to backcountry users is this: when we are unconsciously aware of our mortality, we are more likely to do things that re-affirm our aliveness (such as sending that cliff or high-marking). I propose that our engagement in avalanche fatality mitigation (reading the forecast, pits, beacon checks) is an unconscious reminder of our impermanence. That minor existential threat actually increases risk-taking behaviors. Terror Management theory also tells us, though, that direct awareness of existential threat reduces the likelihood of its effect. In fact, the more consciously aware we are of our impending doom, the safer we act.

While the researchers have yet to turn their attention to the mountaineering community, I suspect that their theory may help explain summit fever. Every one of us knows the effect a glimpse at the summit has on group dynamics. Suddenly, we have forgotten our hunger, our fatigue, our fear, in service of a greater objective—reaching the top. Perhaps, as we experience some of the weariness inherent in a long push, we are subtly reminded of our vulnerability and we manage this crisis by achieving the summit (skiing the line / riding the ridge).

Finally, a rather nasty brain trap is the **sunk cost bias**. This theory, which has its roots in economic theory, proclaims that individuals tend to consider time, money, and resources already expended when making decisions about the future. That is, we are likely to consider things such as how long it took us to get to the trailhead or the top of a line, when deciding whether or not to ride the slope, *even though our future decisions have no way of bringing back that which is already spent*. Sunk cost rests upon the notion that humans do not wish to be wasteful. That is: we will make decisions to seem (to ourselves and others) economical. It is the motivator behind carrying forth with a plan despite signs and indicators that it is unwise.

A few seasons back, some friends and I had planned a rather ambitious mountain trip. Though the weather did not appear to be cooperating, we had already divvied up our gear, separated out food rations, and set a departure time. My friends had recruited a babysitter for the weekend, and we had all taken time off of work. We had even purchased a fancy new rope for the excursion. The weather, however, had other plans, and looked wretched for the dates we had outlined. The night before we were supposed to leave, one partner said "we have to at least try… it would be a shame not to…" His statement should have triggered me to think of this particular brain trap, his words "it would be a shame not to" code for "waste" and "sunk cost." We set alarms for two am, anyway, and (surprise, surprise) postponed the trip before we even got to the trailhead (though we did leave our houses and drive most

Anna Easley makes her way down a luge course after a series of lazy-brain decisions. *Photo Sara Boilen*

of the way there). Our sense was that we had put too much effort, time, and money into the enterprise and not succeeding, or even simply trying, was a waste. I have persisted on sketchy ridgelines, skinned through rain, and ventured into more than a terrain trap or two because I had "already come this far."

As you might have guessed from the psychologist who repeatedly falls victim to her own brain's lazy ways, knowing about heuristics does not, unfortunately, assist our brain avoid the traps.

Good thing psychology has some ideas about how to improve our decision-making. First, consider assigning a daily **devil's advocate**. This person, who should have a high level of skill and confidence in snow safety, is tasked with speaking up early and often about the risks and signs of instability. The devil's advocate's big picture job is to counterbalance the effects of anchoring and confirmation bias.

Next, ensure that your group has a **menu of options**, with at least two potential plans for the day. Do not call these plan A and plan B because we all know we'd rather do plan A (it's obviously better). Call them, instead, plan N and plan K, for example, and make them each desirable and attainable, and dependent on pre-arranged conditions, for example: "if it's been too windy then we will go ski the Z-Trees instead of the R-ridge." Maintain the options throughout your pre-trip planning as well as out in the field.

Keep your confidence in check by always doing **post-mortem analyses**. By surmising, out loud, what would be said about our avalanche in an incident review, we may bring the existential threat into consciousness, reducing the threat of terror management. Moreover, post-mortem analyses provide us with some metacognitive (thinking about thinking) perspective to keep watch over our lazy brains (and hopefully keep them in check as well).

Finally, incorporating this into group **debriefs** can also help keep our lazy brains active and out of heuristic traps. Perhaps after digging a pit, discuss with your peers what you expected to find, compared to what you actually found (i.e. "I was really expecting to see widespread surface hoar but it turned out to be more specific"). Moreover, acknowledge how the knowledge you gathered throughout the day might have changed the choices you made (i.e. "Next time we ride this line with a wind slab problem, I will stop down there, not up here."). Debriefs don't have to just occur at the end of our tour; early and often debriefs help your group manage confirmation bias threat every step of the way.

I propose that we integrate these, and other techniques employed by clinical psychologists, to enhance the safety of our backcountry communities. From that place, one of less laziness, we may find greater safety.

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HOW OLD ARE THE PEOPLE WHO DIE IN AVALANCHES?

A look into the ages of avalanche victims in the United States (1950–2018)

BY ERICH PEITZSCH, SARA BOILEN, SPENCER LOGAN, KARL BIRKELAND, AND ETHAN GREENE

Note: This is a condensed version of a research article published in the Journal of Outdoor Recreation and Tourism. *Please see the full article for full details.* https://doi.org/10.1016/j.jort.2019.100255

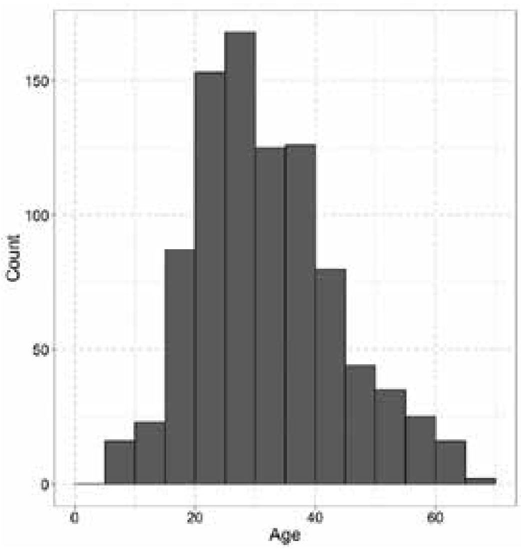

Figure 1: Histogram of ages of avalanche victims from 1950–2018 (n = 900).

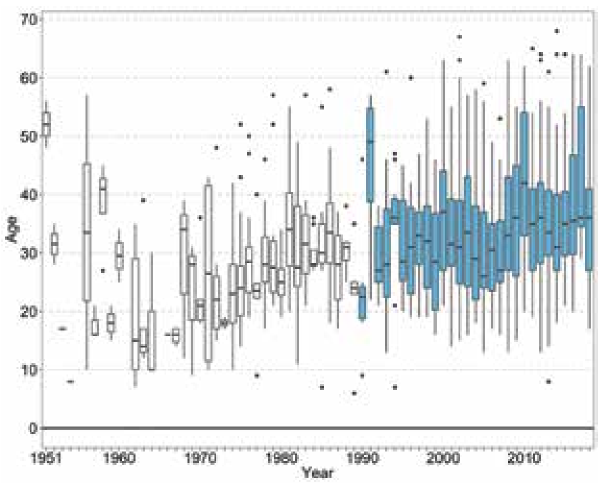

Figure 2: Boxplots of ages of avalanche victims per avalanche year. The white boxplots depict the years 1950 to 1989, and the blue boxplots represent 1990 to 2018 (see Sec. 3.1). The three years with no available data (1955, 1961, and 1965) are included on the x-axis.

wipers flap to Navajo
chanting & heavy snow
Waiting to close pass

1. INTRODUCTION

Avalanches have killed 1084 people in the United States since 1950. In the last 10 avalanche years (avalanche year defined as September 1 to August 31[1], an average of 27 people per year died in avalanche accidents in the United States [2]. Winter backcountry visits increased over time [3,4], yet the number of avalanche fatalities has not mimicked this trend. Birkeland et al.[5] report that the number of avalanche fatalities from 1995 to 2016 was steady with 25 to 30 avalanche fatalities per year. They also account for increases in winter backcountry use by using avalanche center website visits as a proxy. If the fatality rate increased proportionally, there would be more than 200 fatalities annually.

Several studies report the age of avalanche victims in the United States[6,7], and two studies examine ages in light of user groups[8,9]. Winkler and Techel[10] also report an increasing age of avalanche victims in avalanche accident data from Switzerland. Other research examined trends and some demographic patterns (i.e. temporal trends and primary activity) of avalanche fatalities[11-13]. However, previous work has not provided a detailed examination of the ages and primary activity of avalanche victims in the United States.

A better understanding of the age of people who died in avalanches could improve targeted public messaging and education. Therefore, the objective of this study is to examine the ages of avalanche accident victims in the United States, including any differences in the ages of activity undertaken and trend of fatalities within various age groups.

2. DATA AND METHODS

2.1. United States National Avalanche Accident Database

We used a United States avalanche fatality dataset maintained by the Colorado Avalanche Information Center (CAIC)[2]. These data are widely available to the public and document 1084 avalanche fatalities. Ages were only recorded for 835 of those fatalities in the dataset from the CAIC and were only current to the year 2012, with a few years where ages of avalanche victims were unavailable. We used three additional sources to supplement this dataset: *The Snowy Torrents—Avalanche Accidents in the United States 1996–2004*[14], avalanche.org[15], and popular media articles and avalanche accident reports archived on the internet. These sources allowed for a total of 900 records of avalanche fatalities with associated victims' age.

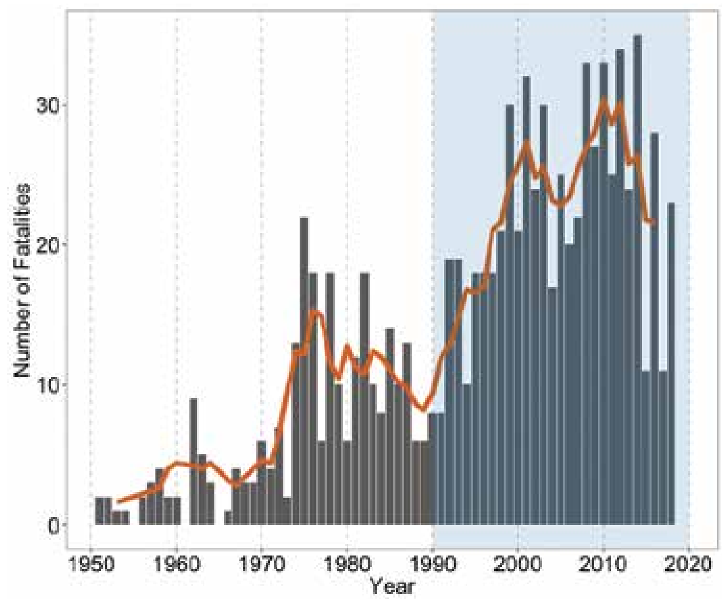

Figure 3: Time series of the number of fatalities with age recorded from 1950 to 2018. The red line represents a 5-year moving average, and the blue shading represents 1990 to 2018. Year indicates avalanche year, i.e. if an avalanche occurred in December of 1950, it was recorded as 1951.

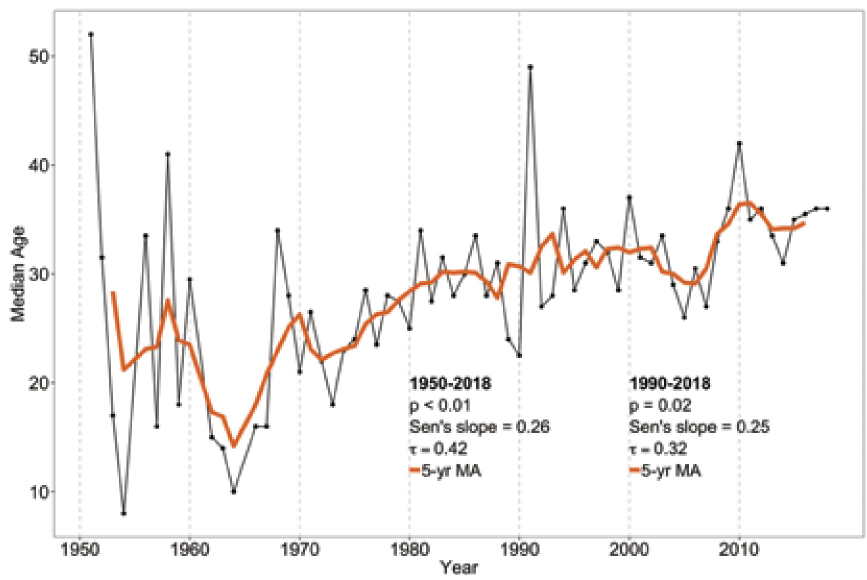

Figure 4: Time series of median age from 1950 to 2018. The red line represents a 5-year moving average.

2.2 Statistical Analysis

Throughout the analysis we consider test results with p-values < 0.05 to be significant. However, in light of recent literature and discussion on statistical significance, we relax this strict threshold when values are near the 0.05 value[16, 17].

We examined the time series of the full dataset of fatality counts (1084 fatalities), the counts of the age dataset (900 fatalities), and the annual median age dataset (65 years) for any significant ($p < 0.05$) change points using a non-parametric Pettitt test[18]. This tests for a shift in the central tendency of a time series. Using this test allowed us to statistically determine a point in time where the number of fatalities or the age of fatalities significantly change. We then used this year to separate the time series for subsequent trend analysis.

We applied the Mann-Kendall test for trends[19] to all datasets for comparability. Finally, we compared ages for various activity categories. For this study, and defined by the CAIC database, backcountry tourers and sidecountry riders are defined as skiers and snowboarders traveling in an area that is not part of an active avalanche hazard mitigation program. Sidecountry riders access this area from an operating ski area. We compared snowmobilers (including motorized snowbikes) to backcountry tourers/sidecountry riders as well as snowmobilers to all other activities for any significant differences.

3. RESULTS

The median age of avalanche victims from 1950 to 2018 was 31 with a range from 6 to 68 years old (*Figures 1 and 2*).

3.1 Change point detection

A significant change point in the median annual age of avalanche victims time series (65 years) existed at the year 1990 ($p < 0.01$) (*Figure 1*). For the full CAIC dataset of the annual number of fatalities (1084 fatalities) the change point was 1991 ($p < 0.01$), and the change point for the full count dataset of fatalities with ages recorded (900 fatalities) was also 1991 ($p < 0.01$) (*Figure 3*).

3.2 Trend analysis

The number of avalanche fatalities with age recorded trended positive from 1950 to 2018 using a non-parametric Mann-Kendall test ($p < 0.01$, $\tau = 0.68$, Sen's slope = 0.44). A positive trend also existed in the number of avalanche fatalities with age recorded from 1991 to 2018 (n = 636) ($p = 0.01$, $\tau = 0.33$, Sen's slope = 0.40). However, the complete national dataset of all avalanche fatalities exhibited no trend from 1991 to 2018 ($p = 0.51$, $\tau = 0.09$, Sen's slope = 0.13).

The full time series (1950 to 2018) of median age of avalanche exhibits a significant positive trend in median age ($p < 0.01$, $\tau = 0.42$, Sen's slope = 0.26) (*Figure 4*). The 1990 to 2018 median age time series also trends positive ($p = 0.02$, $\tau = 0.32$, Sen's slope = 0.25) (*Figure 4*).

3.3 Age groups

All age groups, except the Under 20 category, exhibited a positive trend from 1950 to 2018 in the number of avalanche fatalities (*Figure 5*). From 1990 to 2018, only the 30-39 group exhibited a significant positive trend in a strict statistical sense in the number of avalanche fatalities ($p = 0.02$, $\tau = 0.32$, Sen's slope = 0.17; *Figure 5*). However, there is a positive trend in the 40-49 age group as well when relaxing the strict cutoff of $p < 0.05$ ($p=0.07$).

3.4 Age and activity

Of the individuals in their 30s who died in avalanches from 1990 to 2018, 85 (57%) were backcountry tourers or sidecountry riders and 64 (43%) were snowmobilers. Similarly, of the individuals in their 20s, 92 (61%) were backcountry tourers or sidecountry riders, and 60 (39%) were snowmobilers. In the overall dataset with age and activity both recorded, 258 (55%) were backcountry tourers or sidecountry riders and 213 (45%) were snowmobilers.

There was no significant difference between the median age of snowmobilers, 35 years, from 1990 to 2018 and the median age of backcountry tourers/sidecountry riders, 31 years ($p = 0.15$, Manny Whitney U-test, *Figure 6a*). There was also no significant difference between the median age of snowmobilers and the median age of all other activities, 32 years, from the same period ($p = 0.21$, Mann Whitney U-test, *Figure 6b*).

The number of fatalities of both snowmobilers and backcountry tourers/sidecountry riders with ages recorded trended positive from 1990 to 2018 ($p = 0.03$ and $p = 0.04$, respectively, *Figure 6c*), but the trend of all fatalities from the full national dataset with activity recorded was not significant for either group ($p = 0.09$ and $p = 0.11$, respectively). The median age of snowmobilers exhibited no significant trend from 1990 to 2018 ($p = 0.57$), while a positive trend existed for backcountry tourers/sidecountry riders ($p = 0.04$) and all other activities ($p = 0.01$).

4. DISCUSSION

Results from the period 1990 to 2018 are most germane to current avalanche practitioners. As per Birkeland et al. (2017), and in light of the reported significant change points, it is important to note that the 1990 to 2018 time series reflects a shift in the dataset of both age and number of avalanche fatalities and more accurately describes current trends.

As Birkeland et al.[5] point out, it is important to segregate the time series to account for a marked shift in snowmobile and backcountry touring gear technology, and for the effects of increased avalanche education and forecasting efforts. This likely explains the absence of a significant trend in either direction in total avalanche fatalities in the United States since 1995. Our results are consistent with Birkeland et al.[5] indicating the absence of a significant trend using non-parametric tests:

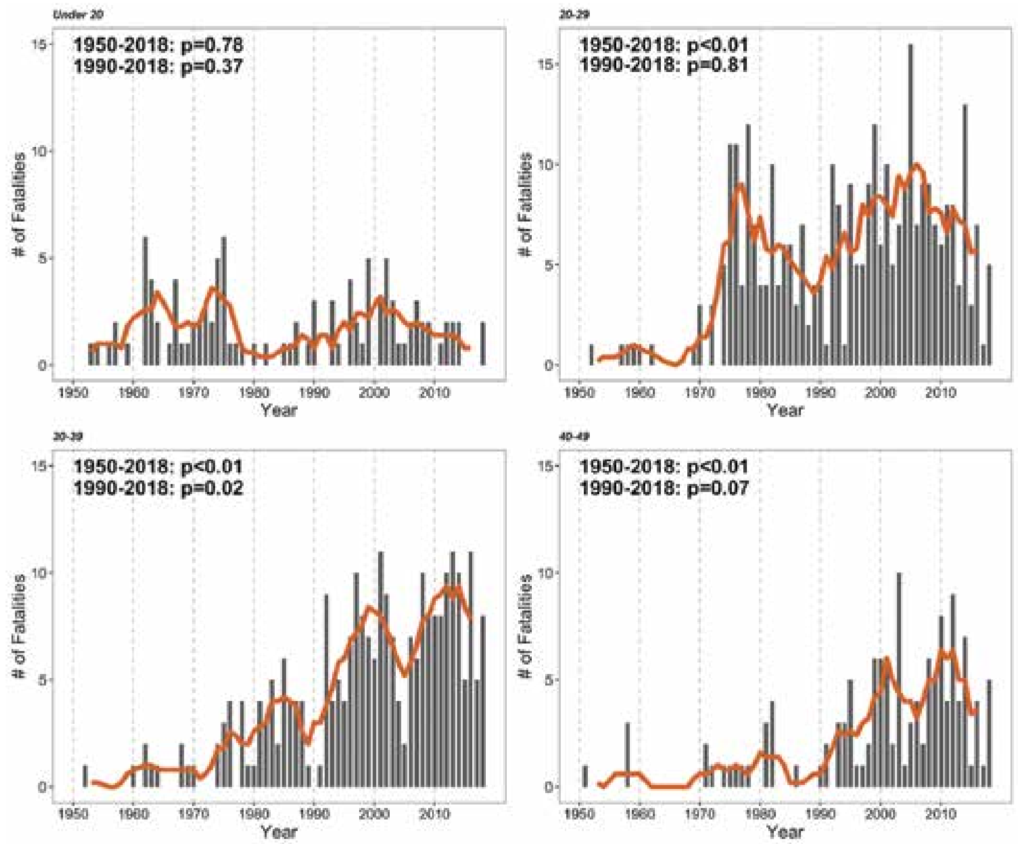

Figure 5: The number of fatalities for each age group from 1950 to 2018 (upper left: Under 20, upper right: 20–29, lower left: 30–39, and lower right: 40–49). Age groups 50–59 and 60–69 were omitted due to small sample sizes. The red line represents a 5-year moving average. The p-value represents the significance of the trend (significant at $p < 0.05$ for the specific time period.

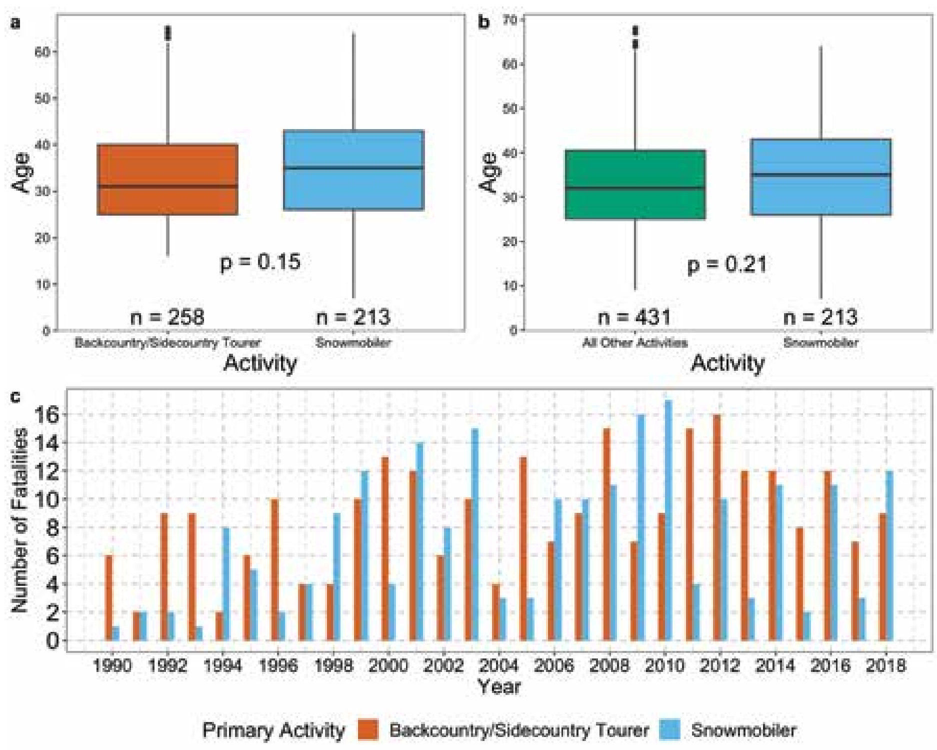

Figure 6: a: Boxplots illustrating the distribution of ages between snowmobilers (blue box) and backcountry tourers/sidecountry riders (red box). b: Boxplots illustrating the distribution of ages between snowmobilers (blue box) and all other activities (green box, including backcountry tourers/sidecountry riders). c: Number of fatalities of the three main primary activity groups (backcountry tourer/sidecountry rider combined, red, and snowmobilers, blue) from avalanche years 1990 to 2018.

we detect no significant upward or downward trend in the total number of avalanche fatalities since 1991.

4.1 Age of avalanche victims

The median age of avalanche victims from 1990 to 2018 in our dataset, 33, is the same as that found by Boyd et al.[9] for avalanche fatalities in Canada from 1984 to 2005. In our full time series dataset, the median age of backcountry skiers, 32, and snowmobilers, 35, is also similar to those reported by Boyd et al.[9] 32 and 36, respectively. In Switzerland, Winkler and Techel[10] report that the median age of avalanche victims from 2004 to 2013 is 39 years, slightly greater than that found in our dataset.

The positive trend in median age from 1990 to 2018 in our results indicates that avalanche victims are older in recent years than in the past. This is similar to other work reporting increases in ages of avalanche victims. Atkins and Williams[8] report the average age of avalanche victims in the United States rose from 27 in the 1970s to 32 in 1999. Soulé et al.[20] found an increasing age of avalanche victims in France from 35 in the 1980s to 40 in the 2000s. Winkler and Techel[10] also found an increase from 33 in the 1994 to 2003 period to 39 years in 2004 to 2013 period.

4.2 Activity and age

There were no significant differences in median age between snowmobilers and other activities in this dataset. This indicates that differences in activity, and associated age, cannot fully explain the positive trend in median age throughout the dataset of avalanche fatalities. The user groups of fatalities in our dataset are similar to other findings in both the United States and Canada[8, 9]. Atkins and Williams[8] illustrate the increasing number of snowmobile-related avalanche fatalities in the 1990s. This, as previously mentioned, is likely linked to the increase in snowmobile technology allowing riders to venture further into and spend more time in avalanche terrain[4, 5, 21]. From 1984 to 2005, Boyd et al.[9] report that snowmobilers represent 22% of Canadian avalanche fatalities, while backcountry tourers account for 30%. These are similar ratios of backcountry skiers to snowmobilers in our dataset as well. However, our results indicate that there is no clear evidence that an increase in snowmobile use since 1990 explains the increase in fatalities of individuals in the 30-39 or 40-49 categories.

The number of fatalities of both snowmobilers and backcountry tourers/sidecountry riders with ages recorded exhibited a positive trend, but the full CAIC dataset showed no significant trend for any activity. While the full dataset provides a more complete perspective on trends of activities of avalanche victims, both results provide further evidence that increasing ages of avalanche victims cannot be explained by an increase in snowmobile use. However, the significant positive trend of median age of backcountry tourers/sidecountry riders suggests that these activities are a driver of the increasing age.

4.3 Limitations and future research

Soulé et al.[20] discuss the limitations of studies such as ours without knowing the parent population profiles (the ages of those traveling in avalanche terrain overall). Without knowing the parent population of these user groups, it is often challenging to interpret results. Parent population demographics for the age distribution of backcountry travelers are currently unavailable. However, the International Snowmobile Manufacturers Association reports that the average age of a snowmobiler is 43 years old[22]. This is greater than the median age of snowmobile avalanche victims in our dataset, but includes all types of snowmobilers, not just mountain snowmobiling. The Outdoor Foundation[23] reports that participants aged 25-44 comprise 29% of all outdoor recreation participation, and those aged 45 and over comprise 36% of participants. These limited data provide some context for the age distribution of avalanche victims, but cannot truly serve as a parent population or proxies for comparison purposes.

It is likely that the increase in age of avalanche victims cannot be explained by any single factor, but rather a combination of factors as well as others beyond the scope of this discussion.

Again, without parent population profiles, interpretation is challenging.

It is also worth exploring if the increase in avalanche fatalities is a function of the age group or the actual cohort. In other words, will the trend continue for those in the 40-49 and 50-59 age group in the future or persist within the 30-39 and 40-49 age group? Regardless, the results illustrate an important pattern in the age of avalanche fatalities, and revisiting this analysis within a few years will be worthwhile.

Our results indicate that the age of avalanche victims has increased over time since 1950, and can help inform us about how to tailor avalanche education to older, and perhaps more experienced, user groups, specifically backcountry tourers/sidecountry riders. Avalanche education providers might find it beneficial to provide courses that target older users to help update their avalanche skillset with new techniques or knowledge without spending too much time reviewing older material. Avalanche education providers would need to determine a specific curriculum for such populations based on local and regional interest and knowledge.

Future research should compare the age distribution of avalanche education participants to ages of avalanche victims. This would aid in understanding if a lack of, or lapse in, avalanche education (i.e. no avalanche education for many years), influences the trend of increasing age in avalanche victims.

While a combination of factors likely explains the increase in age of avalanche fatalities, we emphasize that the overall trend in the number of avalanche fatalities occurring every year currently remains flat. These results could help inform avalanche forecasting and education efforts by identifying groups most vulnerable to avalanche accidents. This, in turn, helps the avalanche community target and apply appropriate messaging and educational techniques. For example, the widely used "Know Before You Go" program (www.kbyg.org) primarily targets youth. If current trends continue, an additional program primarily targeting an older age group may be warranted.

6. ACKNOWLEDGMENTS

We thank Zach Miller of the USGS for assistance compiling missing data for this dataset. This is a contribution supported by the U.S. Geological Survey Land Resources Research and Development program, Western Mountain Initiative. All authors thank everyone who reports and documents avalanche accidents. We also thank the reviewers and editor of this manuscript. Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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In Senja, Norway with A3 pro member Spencer Jonas—the essence of good partnership. *Photo Ryan Krueger*

THE IMPORTANCE OF PARTNER SELECTION AND EVALUATION

JUDGMENT DAY

BY DREW POGGE

On my first overnight winter camping and ski trip, my two partners and I thought we had it all figured out. We had a Coleman three-season tent, some 50-degree sleeping bags, skins cut an inch too narrow for our skis, and all the enthusiasm three college freshmen could muster. We skied a few miles into the Montana backcountry, set up camp, and proceeded to ski a couple nice lines—we were killing it! But when we returned to camp famished and ready for a hearty dinner, we each looked expectantly at the others. Dude, I thought you had the food! After some passive-aggressive blame-casting and pouting, we discovered that while we didn't bring any real food, we did have an enormous bottle of rum. I'd be lying if I told you that we didn't have fun that night, but the inevitable hangover and fully-loaded ski out the next morning were horrific on an atomic level. We didn't ski together much after that experience. Turns out, at a pretty basic level, none of us were very good ski partners.

In avalanche terrain, the stakes are high, and yet it seems that partner selection for many of us isn't much more refined than finding acquaintances nearby who happen to ski or ride in the backcountry. Why is that? And is there a better way?

I was drawn to the idea of partner selection recently, after I noticed that I'd been avoiding a couple of my longtime backcountry ski buddies for reasons that at first weren't clear. After thinking about it in greater depth, I discovered that I'd simply selected them out; they no longer met my criteria as ski partners (more on this later). Not only that, but I replaced them with other partners who did fit my criteria. I felt a little bad, and became curious about how other people evaluate and choose their partners, and whether their criteria—and partners—also change over time.

Partner selection is not a new topic, and the criteria that help define a good partner haven't changed: education and experience, emergency preparedness, similar risk tolerance, good communication, complementary heuristic bias, fun personality, etc. But partner selection is often lumped into discussions about Human Factors, and somewhat glossed over in terms of best practices, when in fact, who we choose to recreate with may have the greatest impact on where, when, and how we ultimately decide to ski or ride.

So, over the last two seasons, I've conducted a strictly anecdotal, painfully unscientific, and completely off-the-cuff poll of approximately 150 avalanche course students—Level 1, Rescue Fundamentals, and Recreational Level 2—with mixed levels of prior education and experience. In the context of course lessons and during post-course follow-up, I've asked these students about how they typically select and evaluate their backcountry partners. I believe their answers, while generally unsurprising, demonstrate a need for greater emphasis in avalanche education on the **importance of appropriate partner selection** while traveling in avalanche terrain, along with **tools for partner evaluation**. Anecdotally (again, no science here!), there are two major ways that these recreational skiers select partners: **availability and social proximity**.

I asked students "What criteria do you use for finding ski partners on any given day?" Across all levels of experience and prior education, **partner availability** was the number one criterion. *Hey, you backcountry ski, right? Can you get out Saturday? Perfect—pick you up at six!*

The second-most common criterion was **Level 1 Avalanche training**, which is good, but not great, since a Level 1 certificate doesn't mean a whole lot without the context of experience and thoughtful reflection. This represents a "license to the backcountry" attitude toward avalanche education that course providers know all too well.

From there, answers varied, and were less easy to categorize ("good skier," "carries good snacks," and my personal favorite, "not a moron.")

I also asked students "How did you meet your backcountry partners?" The overwhelmingly consistent answer was **social proximity**: "my roommate got me into it," "we started backcountry skiing together," "friends of friends," "my buddy from work." Not only does partner selection appear to depend greatly on preexisting relationships, but people who begin backcountry skiing together often continue skiing together, regardless of other factors. It's hard to shake that kind of loyalty unless you really screw up!

OK, so it's been established that skiers who know each other, often go skiing together when they're both available. Groundbreaking findings, I know. Is this behavior bad? Not inherently, of course, but we're all susceptible to **entrenchment.** Backcountry partnerships are social relationships, and it's hard to "fire" a partner, or warm up to a new one. It takes energy and time to maintain and modify these relationships, both of which are in short supply for many of us. But what if there's a problem? And what are the most important criteria to consider, if not availability or proximity (or quality of snacks)?

The theme that emerged from my personal partner selection inquiry came down to **judgment.** Without dragging Kant's Transcendental Idealism into this mess, I look at judgment as our ability to make evaluative decisions; it's the framework onto which we pin observations, forecasts, season histories, and past experiences, and through which we calculate our personal risk tolerance. The amount of risk we choose to accept may change day to day, and partner to partner, but judgment (the ability to make those risk decisions rationally) is constant and independent of environment—and that includes life outside of the mountains. The way I've presented this idea to my students is this: **If someone displays poor judgment regularly in day-to-day life, don't expect any better in avalanche terrain.**

This seems to resonate with people. Several of my students have told me that after considering their partners in this way, it's caused them to rethink some of their backcountry relationships. We probably all know people who are amazing skiers or riders, but consistently demonstrate poor judgment; they're generally well-known for both. Getting DUIs, accruing bad debt, cheating on spouses, getting into physical altercations—the examples go on forever, and the party never ends. These people may have ample education, a ton of outdoor experience, and have done super impressive things in the mountains—on paper, they may look like rock-star ski partners. The optics are further blurred by the fact that in the winter sports and outdoor recreation world, we tend to celebrate extreme risk-takers. But accepting risk while using good judgment is different than making poor decisions based on bad judgment.

Judgment matters. After everything else is stripped away, it's the best tool we have. However, evaluating this quality in our partners while navigating avalanche terrain is tricky—there are a ton of factors and complex motivations at play—which is why I've found it helpful to look for examples in other parts of life, independent of skiing or riding in the backcountry.

In the case of my partners, there was no acute event that caused me to distance myself from them. I simply realized, almost subconsciously, that these people (some of them close friends) were consistently displaying poor judgment in areas of their lives outside of our relationship in the mountains. Furthermore, the negative consequences of their actions didn't seem to change their behavior; one bad decision often led to another. For me, it cast into doubt their ability to hold up their end of the contract that we implicitly make with our mountain partners. But bad judgment doesn't make someone a bad person. We're still friends, I just choose not to travel in avalanche terrain with them anymore. We'd reached a point where we were skiing together not because we were excellent partners, but because we'd always done so; because we were available; because we lived nearby; because it was easy.

Is there a difference between poor judgment and high tolerance of risk? Sure. *But if someone displays poor judgment regularly in day-to-day life, don't expect any better in avalanche terrain.*

DIVEST NOW!

BY TRAVIS FEIST

If you're reading this, there's a good chance you're a skier. It's less likely, but still possible, that you're a snowboarder. If these assumptions seem so obvious to you that it's an absurd way to open in *The Avalanche Review*, you're my target audience. Please read on.

The avalanche industry has a snowmobile problem. Snowmobilers keep dying in avalanches (in Wyoming that user group now has more fatalities than any other), but avalanche professionals don't seem to know what to do about it. When several snowmobilers died last season in separate accidents, and didn't even have basic avalanche gear, many of us felt exasperated—WTF?! After all the outreach done over the past decades, how could snowmobilers continue to be so ignorant?

The root of the problem is not the ignorant snowmobilers, it's our assumption that the avalanche industry is a subset of the ski and snowboard industries. We make this assumption, and then build a culture around it that's biased against snowmobilers. Our "outreach" to them suffers across the cultural divide.

But as with most biases, it's difficult for us to acknowledge or understand it. Another assumption might help illustrate: Many of you are probably also climbers and mountain bikers, and you're familiar with the well-known non-profits that promote public lands access for those sports. Imagine there were equally successful organizations hell-bent on doing the opposite; the "Anti Access Fund" (AAF) and the "No Mountain Biking Association" (NMBA).

In this bizarro world, it's the cultural norm to support the AAF and NMBA. Your small mountain town is overrun with people wearing brands X, Y and Z clothing, which all sponsor the AAF and NMBA. Film fests that mark the beginning of the season serve as fundraisers for the AAF and NMBA. The social hour at your regional Snow and Avalanche Workshop features adult beverages associated with the AAF and NMBA. Volunteers for the AAF and NMBA hang out at local trailheads, and successfully get your friends to sign petitions against climbing and mountain biking. Because, of course!

This is the welcome the avalanche industry offers to snowmobilers when we assume that we're all skiers and snowboarders, and by extension we assume it's acceptable to affiliate with anti-snowmobile campaigns. Our avalanche forecasters wear brands X, Y and Z gear, as do our ski patrollers (seen by plenty of snowmobilers who also ski and snowboard). Our advisory Web sites run ads from companies who also sponsor anti-snowmobile organizations. Our "Friends" groups are listed as sponsors; the beers we serve at avalanche functions are sponsors; this very issue of *The Avalanche Review* has ads from sponsors; our classrooms are filled with banners from them; etc.

Here's a crazy component of our snowmobile problem that should be bizarro except it's true—many of the companies that make avalanche rescue gear don't market to snowmobilers, and some even sponsor anti-snowmobile organizations. There's one obvious exception, and another manufacturer that has a creative work-around: The main company is openly anti-snowmobile, but the subsidiary markets to snowmobilers as if they will never notice. And we wonder why there are still snowmobilers who don't own rescue gear?

The avalanche industry has a snowmobile problem, and to fix it we must separate ourselves from anti-snowmobile organizations and the companies that support them. Divesting from certain industry partners might be inconvenient, but if snowmobilers are stakeholders in whatever corner of the avalanche industry you represent, that's a poor excuse. Motorized sports represent a significant portion of the billions of dollars spent annually on outdoor recreation in the United States. Sponsorship will come from that market segment eventually, but divestment needs to happen first. The snowmobile industry is watching us with suspicion, and until we divest from anti-snowmobile campaigns, that suspicion is well deserved.

Even if your role as an avalanche worker doesn't involve partnership decisions, it's worth a few online searches to learn how pervasive this issue is in our industry. Try "anti snowmobile" as keywords to start, and follow the rabbit hole from there. Better, find a few passionate snowmobilers and invite them out for beers to get their perspectives.

The next time a co-worker questions why snowmobilers don't take our avalanche classes; don't buy our rescue gear; don't attend our SAWs and social events; and don't contribute to our forecast centers, you'll have a simple answer: **Instead of welcoming snowmobilers, our industry is repelling them.** And, if anyone questions why snowmobile professionals (guides, athletes, photo/videographers, industrial workers) don't associate with us as "avalanche workers," the answer is the same.

It's entirely acceptable for you, the individual, to feel however you want about snowmobiling. Sign petitions, write letters, and drink more beer from the breweries that support your stance. But as avalanche professionals, collectively we need to change our assumptions about who we are and what we stand for.

Travis Feist burned his brand X, Y and Z gear several years ago, and used two stroke oil to start the fire.

IN REPLY:

BY LYNNE WOLFE, EDITOR

Travis thanks for your heartfelt rant/letter to the editor.

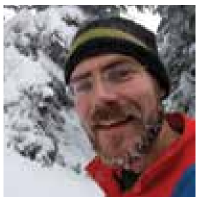
I think your arguments have relevance, and after reviewing the sledder forums I can see at least part of your perspective, especially as a mountain biker.

In response, I'd like to applaud the work that many avalanche centers and companies have done and are doing to bridge this gap. Many more riders are educated compared to 10 years ago.

I'd like to see the true avalanche community be "bigger" and more "non-denominational" than simple allegiances to/away from Wilderness and motors. Our job as a community and as an industry is to keep people from dying in avalanches, and the rest of your beliefs/methods of travel are irrelevant, although all of them need attention.

Wind & deep snow—
avalanching…
ROAD CLOSED

CONTRIBUTORS



Charlie Hagedorn is a physicist and backcountry skier from Seattle, WA. He wants you think about parties above you and below you this winter.

Emerging from the legendary ski town of San Diego, **Jeff Deems**' skiing habit was solidified in Colorado mountain towns. Degrees from Montana State and Colorado State added a small measure of legitimacy to that pursuit. As a researcher at the National Snow and Ice Data Center at CU Boulder, and a co-founder of the Airborne Snow Observatory, Jeff studies spatial variability in snow properties.

Erich Peitzsch is a Physical Scientist with the USGS Northern Rocky Mountain Science Center in West Glacier, MT.

Sara Boilen, PsyD, is a clinical psychologist who owns, and serves her community, at Sweetgrass Psychological Services in Whitefish, MT. An avid mountaineer and backcountry skier, Sara also provides education about human factors to backcountry users in Northwest Montana.

Steve Conger began his contributions to the avalanche community with the creation of the first snow crystal card and waterproof field book for recording snowpack profile observations. Steve is an editor emeritus of *The Avalanche Review* and an instructor for the Canadian Avalanche Association Industry Training Program. He lives in Golden, BC.

Drew Pogge owns Big Sky Backcountry Guides and Bell Lake Yurt in Bozeman, Montana, is on the board of A3, and is former editor of *Backcountry Magazine*. His judgment is far from perfect—he's based his entire professional trajectory on skiing powder.

A3 at-large trustee **Sean Zimmerman-Wall** gets around. Not only does he bring his trademark energy and thoughtfulness to the A3 board, but he also patrols at Snowbird, advises AIARE on curriculum, is a freelance journalist, and he and his wife have two small children. So of course he has time to visit Croatia and write an article about his experience teaching avalanche rescue to the Croatian Mountain Rescue Service.

empty storm boards—
corn season ends in mud—
grieving begins

Ode from an Avalanche

My name is Avalanche, and you must try—
To understand me, or you may die.
My lair lies here, and it lies there—
On steep snowy slopes, almost anywhere.
I'm shaped by wind, and by the snow I receive—
In many layers and strengths, that can deceive.
Changing with temperature, and stressed by rain—
I weaken in sun with slides that bring pain.
So use care when you travel, in my homeland steep—
Or you'll be alone and hurt, or buried deep.
Already a month past winter, and it's not a fable—
That it will take time and warmth to make me stable.
But as we advance in spring, and I warm, melt & weaken—
To be safe in my home will take more than a beacon.
You'll need to focus, respect and not rely on your gear—
For I'll show many signs that my release time is near.
And if you really don't care or just don't know—
I urge you to stop before you're covered by snow.
Fueled by thoughts of powder, adventure or fame—
It's really not worth playing my avalanche game.
Though I may be soft and enticing, and very alluring,
Once I start to slide, my strength is enduring.
Life's a good thing and fame is fleeting—
Learn about me and we won't have to be meeting.
Thanks for listening
—A . Avalanche
(with Mark Moore, 20 April 2012)

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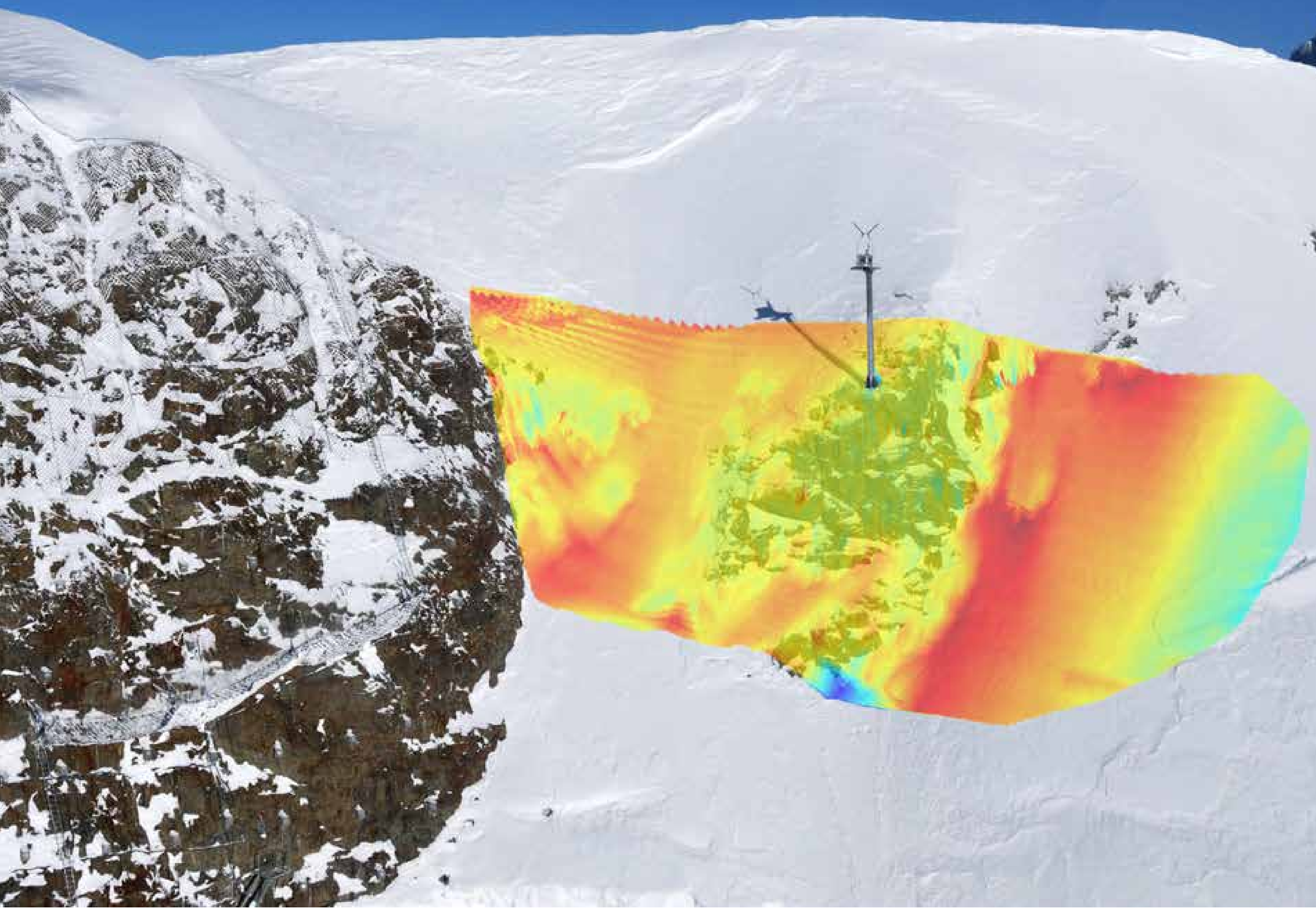
3D Laser measurement of changes in snow accumulations in the **avalanche release area**



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THE AVALANCHE REVIEW
PO Box 7019
Bozeman, MT 59771

PresortStandard
US Postage Paid
Permit #592
Pontiac, IL

A Publication of the
American Avalanche Association

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