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FALL 2021

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

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the AVALANCHE REVIEW

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Please send submissions to:

Lynne Wolfe — Editor
tel: (208) 709-4073
avalanche.review@avalanche.org

Design & Production:

McKenzie Long — Designer
tel: (513) 515-0723
mckenzie@cardinalinnovative.com

Business, Subscriptions, & Advertising:

Jayne Thompson Nolan — A3 ED
tel: (307) 360-9099
jayne@avalanche.org

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FALL 2021

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Beware the brown frown. ■ AAIC

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BONUS: To pay respect to last season's confluence of bad basal facets and Covid human factors, give *Season of the Witch* by Donovan or the song's cover by AI Kooper a listen on YouTube.



ON THE COVER

February 6, 2021; Cardiff Fork, Central Wasatch. After a long wait, strong west winds and 30 inches of snow were enough to trigger a widespread natural cycle on early-season facets near the ground. Until this storm, most avalanches on this layer had been ragged and poorly connected. This is some of the core terrain in the Wasatch, usually holding some of our strongest snow; it would take another two weeks and almost 100 more inches for the rest of the cirque to flush. Hours after this photo was taken, Utah saw one of its worst accidents in the modern era when four skiers from two separate parties were killed in a hard slab avalanche less than five miles away in the Wilson Glades. ■ COLBY STETSON

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FROM THE EDITOR

Saharan sands coat the Glacier du Geant. ■ JEFF WITT



First TAR of the season, white tops on the high peaks, yellow aspens, crisp temps all mean that it's time to start thinking snow and avalanches.

A STACK OF UPDATES:

This is a fat issue. We added 8 pages since our fabulous new ED Jayne Thompson Nolan recruited several more ads for this volume. Welcome Jayne—glad to have you leading our team. Same amount of fabulous content as usual. In honor of our 40th year of TAR, and our 7th year in the new format, graphic designer McKenzie Long freshened up our layout with a redesign. Pretty stylish, I think... Our 40th celebration will be in the December TAR, so if you'd like to share an anecdote or photo around your relationship with TAR, get it to me ASAP please. Forty years, *hunh*? Thanks so much, Sue Ferguson, for your vision and action.

In putting together this issue and reviewing reports from last season, the theme for this issue began to emerge, but initially I couldn't clearly articulate the intersection of factors that made it significant. The thesaurus wasn't terribly helpful, but former TAR editor Blase Reardon suggested the word *confluence*, which fit my mental image of independent smaller streams of factors (Covid human factors, a widespread nasty basal facet layer, and a February atmospheric river) that merged (arithmetically or geometrically? Do I need a statistician or social scientist for this question?) to create a cascade of avalanche incidents.

So, this issue's theme became **A Confluence of Factors**.

I still don't have a coherent vision that incorporates the patterns from winter 2020–21 into my practice, but I think my lessons will end up involving humility and contemplation and patience, which are much harder to internalize and evaluate than a new tap test or piece of vocabulary.

Read through this issue, friends, and let me know what lessons come to you from last year, and how you're going to interpret them for this year. I try to set you up with fodder for thought and action for you to remember when it starts to snow. Maybe you'll remember the Short Stack Strategy (page 22), or hear Chris Lundy very clearly saying to dial it back (page 18), or perhaps you closely fit the profile of many of our accident victims from last year (male, 40s, possibly solo). I try to offer you enough material to think about and process into action for when the snow flies; let me know what sticks.

You'll find the first half of the avalanche center season summaries (split alphabetically except for the Flathead) in this issue. Second half will appear in the Early Winter TAR, 40.2.

If I don't see you at WYSAW in person, then perhaps I'll see you online at one of the other regional SAWs. Keep in touch,

—LYNNE WOLFE



■ ALEX PASHLEY



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■ Bryce Hill



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Over four days in May, new ED Jayne Thompson Nolan, A3 Board President Halsted Morris, and retiring ED Dan Kaveney worked on creating a smooth transition and introduction to A3's many facets and projects.



FROM THE EXECUTIVE DIRECTOR

By the time this issue of *The Avalanche Review* hits mailboxes, my first 90 days as the executive director of A3 will have come and gone. As I write this, though, I'm still in the thick of my first three months on the A3 team.

What's immediately apparent at A3 is that this is a community made up of extremely passionate and tenacious individuals. Having grown up on the periphery of A3, I'm not surprised, but I didn't anticipate the breadth and scope of time, talent, and support that surrounds A3. Our organization's long history (Happy 40th birthday, TAR!) wouldn't be possible without the hundreds of thousands of volunteer hours put in by this community— hours that were likely swapped for much-needed sleep during the forecast season or time with family and friends during the summer months. I'm in awe at the volunteerism that has kept A3 moving forward. With a nod to that history and to each person who has left an impact on A3 and our membership through the years, I'm honored to take this opportunity to talk about A3's next phase.

This fall, A3 embarks on the development of a strategic plan—our first ever! This plan will drive our organizational operations and direction and enable our board and staff to hone our resources on the elements of our work that matter most to our members. By default, this plan will also positively impact the people whose lives are connected to A3, whether it's by education, protection, or rescue in avalanche terrain. Leading this plan is a committee of dedicated A3 board members, advisors, and staff, each representing a different segment of A3's member population. Our new strategic plan will address the following areas of our organization:

- Program—quality, growth, and stability
- Infrastructure—membership, staff/board development and succession

- Marketing & Fundraising—communication, messaging, funding sources

You've likely already participated in the research and information gathering phase of A3's new strategic plan, but any additional comments regarding the process/plan can be passed on to me directly. My personal hope for this plan is that it enables A3 to double down on the programs we've been leading, enhance the benefits of membership, and address areas where we're falling short. This plan will also address A3's diversity, equity, and inclusion efforts—areas that our board committed to in 2020. A3's new strategic plan will be announced in early 2022, so stay tuned!

In addition to strategic planning, our team will be focusing on the following areas in the year ahead:

1. **Re-launching scholarships and research grants**—After a delay due to covid, we're re-allocating and increasing funds to support students, researchers, and A3 members in their pursuit of education and professional development.
2. **Expanding A3's presence at Snow and Avalanche Workshops** around the country—A3 provided \$15,500 in financial support to regional SAWs this year (in-person and virtual). At these events, we hope to connect with members to learn what works and what needs work.
3. **Developing more robust communication and fundraising plans**—Our team is working to expand A3's reach, influence, and financial sustainability.
4. **Supporting our Pro Training providers**—This spring, A3 will begin renegotiating contracts with our Pro Training providers. After several years working under the original agreements related to pro training education, we're excited to step up our commitment to this segment of avalanche education.
5. **Exploring and updating improvements to Avalanche.org**—We're working with the National Avalanche Center as well as regional avalanche centers to make important updates and improvements to this resource.

If you are new to A3 and reading this magazine in the top shack of a local ski hill or on a friend's coffee table, I encourage you to reach out and learn more. The American Avalanche Association and our members have an impact on every person who lives, works, travels, or recreates in avalanche terrain.

I've been so grateful for the warm welcome from this community, and I'm thrilled to be a part of it. At the end of the day, that's what our organization is about: providing community for this incredibly special group of people. If you are one of the many individuals who has supported A3 in some way over the years— thank you. If I haven't met you already, I look forward to doing so. ●

Let the snow fly,
—JAYNE THOMPSON NOLAN

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A3 AWARDS

A3 SPECIAL SERVICE AWARD

All too often we become totally enmeshed in snow, avalanches and other life's activities and forget the contributions of those who have helped us behind the scenes and have worked to develop and provide the opportunities that make our lives easier and our snow and avalanche work more meaningful and understandable. One of these individuals is indeed **RICH MARRIOTT**, the Secretary of ISSW for the past 20+ years. Ever since John Montagne successfully handed off the ISSW gavel, Rich has provided a guiding light, coherence, and affability to this increasingly successful and beneficial merging of theory and practice.

Recently, the avalanche community had the occasion to thank Rich for his work on behalf of avalanche workers and researchers everywhere as the American Avalanche Association presented Rich with the A3 Special Service Award. As the photo below attests and as we all know, the presentation could only be properly awarded at a party—this one a surprise Birthday/Award event for Rich. His tears notwithstanding, this was a joyful event, attended by a host of luminaries including the venerable Weiner, and even featured a special Avalanche Instrumentation Award for Taylor Scientific and Phil Taylor, whose wind and other instrumentation sensors have long been a fixture for avalanche and other programs on remote mountain tops all over the world.

Anyway, a very heartfelt thanks to Rich for helping maintain and expand ISSW into the premier snow and avalanche workshop that it has become. Despite Covid, which put holes in just about everything and every conference out there, we all look forward to **ISSW** when it returns to Bend, OR in the fall of 2023. The Special Service Award Citation follows (consult the digital TAR for a short video on the presentation):

To the Esteemed Mr. Rich Marriott—

As we approach the 50th anniversary of the first ISSW it seems fitting to acknowledge the personal dedication and the insight necessary to make this the very successful and perhaps premier venue for snow and avalanche practitioners and researchers alike to share and exchange ideas, knowledge and experiences. For the first 26 years Dr. John Montagne, as the first secretary of ISSW, was instrumental in making this venue a viable option for sharing wisdom amongst the avalanche community. During the last 20 years this duty has been taken on by Rich Marriott, an outstanding ex-NWAC avalanche forecaster and now a well-known TV meteorologist. During this most recent and increasingly challenging time, Rich has done an admirable job of shepherding the ideas of snow and ice into a wide variety of both national and international venues...and thereby keeping this most important merging of theory and practice alive.

For this great dedication and perseverance in the face of gigantic odds (herding cats comes to mind), the avalanche community is ever grateful to your hard work. And we thank you for all of your time, energy and insight, Rich Marriott, as we offer you this small token of our grateful appreciation and recognition. And despite the bun chilling (June) weather until just recently, the Weiner (may he be resting in flatness at the moment) joins us in this warm salute with great relish!

Sincerely, the worldwide avalanche community and A3, and of course your friend in the Weiner world, Mark Moore. ●

JOHN STIMBERIS



HONORARY FELLOWSHIP AWARD

Herewith, we nominate **KRISTER KRISTENSEN** for the Honorary Fellowship Award in recognition for his long-lasting contribution to avalanche research and education in Norway and internationally.

Krister Kristensen joined the Norwegian Geotechnical Institute (NGI) in 1975, soon after the establishment of the avalanche section at the Institute. Located in Stryn (Western Norway), Krister became responsible for the operation NGI's Research station at Fonnbu and the avalanche test-site Ryggfonn.

In the early years, he spent many months at the Fonnbu station together with Dave McClung, where he made snowpack investigations, which funded the base of many research articles from various authors.

Krister Kristensen was also a key person behind the collection of avalanche runout observations, which culminated in the development of the well-known empirical alfa-beta model for runout estimates by Lied and Bakkehøi.

He was fundamental in the operation of the full-scale avalanche test-site Ryggfonn, which contributed in many ways to the understanding of the dynamics of snow avalanches. Thereby, Krister became among others involved in the development of the so-called PLK-model (Perla-Lied-Kristensen).

Krister contributed intensively to the avalanche hazard mapping effort in Norway. For many years, Krister was also involved in the avalanche warning for defined objects in Norway. These two engagements triggered one of his recent interests as he turned his focus to the quantification of avalanche risk and its uncertainty.

He repeatedly shared his knowledge nationally as well as internationally through presentations and articles and a book.

As a certified IFMGA mountain guide, it came natural for Krister to represent NGI/Norway for years (since 1986) at the International Committee for Alpine Rescue (ICAR). He was central in the development of rescue methods and avalanche courses for the Norwegian Red Cross.

Following the idea of ISSW "A Merging of Theory and Practice," Krister Kristensen was one of the founding fathers of the "Nordisk konferanse om snøskred og friluftsliv," first started in 1994. With that, the group wanted to enhance avalanche awareness in a country with a changing skiing culture. In addition, he taught numerous avalanche courses for universities, educational institutions, and organizations nationally and internationally.

As professional member of the American Avalanche Association, he was representative of the EU-section and Governing Board Member between 2010 to 2017.

On behalf of the group of petitioners
Peter Gauer
Oslo, 19 December 2019 ●



ODE TO ISSW

BY **MARK MOORE**

Once upon a time, a long time ago,
There lived some folks who thought about snow.
How it clung to hillsides, releasing with wind and a roar,
And they wanted to know how and why and much more.
Some lived in the mountains, some nearer to cactus,
But all believed in merging theory and practice.
They had names like LaChapelle, Williams, Montaigne,
Birkeland & Jamieson, all came to the game.
One thing in common united them all,
As they sought to unravel the avalanche call.
From snow flake to snow slide, they were eager to know,
The intricate science behind an avalanche of snow.
So they met in places like Banff and Sunriver,
Where experience and research were part of the quiver.
Most back country accidents had a common theme,
Of life at the limit of an avalanche dream.
Though knowledge has grown thru research and patrol—
It's still up to each one to help reverse the grim toll.
Although the pandemic slowed the information sharing,
The next workshop will show how much we're still caring.

INFORMATION TECHNOLOGY PROMOTES COLLABORATION AMONG AVALANCHE CENTERS



MOUNTAINS IN THE UNITED STATES ARE GEOGRAPHICALLY diverse, stretching from the high latitudes of Alaska down to the low latitudes of California and from the west to the east coast. Avalanche terrain throughout these ranges is equally diverse. US Avalanche Centers (ACs) provide avalanche information and education to reduce the impacts avalanches have on the recreating public. There are currently 22 Avalanche Centers in 12 states: 14 of these are operated by USDA Forest Service, one by the state of Colorado (the largest AC in the group), and seven by private non-profit organizations.

Most ACs grew organically at some point during the last 50 years based on local needs and resources. As a result, public avalanche forecasting in the US is largely decentralized, meaning that each operation is managed and funded locally. This decentralized approach comes with both advantages and disadvantages. Advantages include the potential for nimble operations, rapid innovation, and close cooperation with and service to local communities. Disadvantages include some lack of consistency in public safety products, chronic underfunding, and redundant website and design work between centers.

One aim of the National Avalanche Center is to facilitate systems that encourage and maintain local management while also promoting collaboration, consistency, and quality within the Avalanche Center group.

To this end, we have been working with the American Avalanche Association to build a series of Information Technology (IT) Platforms that promote collaboration and advancement on topics related to public avalanche safety. We call this initiative *Avalanche.org* and it is made up of two parts: the first is the public website (*Avalanche.org*) which showcases danger maps, links to avalanche centers, accident information, and educational materials. The second is a **behind-the-scenes Avalanche Center (AC) Dashboard** which forecasters use to create danger maps, avalanche warnings, weather station maps, and avalanche forecasts.



The *Avalanche.org* IT Platforms are a partnership between the National Avalanche Center (NAC), the American Avalanche Association (A3), and the local Avalanche Centers. *Avalanche.org* is a cooperative enterprise where the NAC manages projects and infrastructure, the A3 provides business services such as banking and contract management, and the ACs provide ideas and expertise.

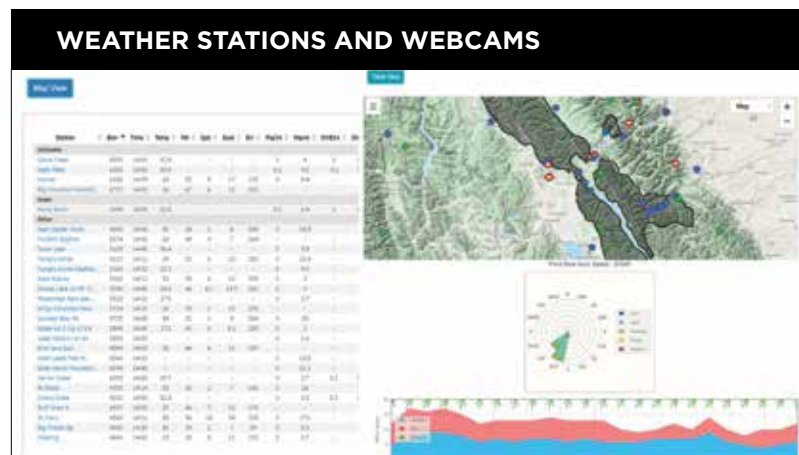
The AC Dashboard displays data in a consistent format on locally managed websites. Avalanche Centers can choose to either use the Dashboard or create their own products and contribute their data to the central database. Current platforms include:

- Danger Maps
- Weather Stations
- Avalanche Forecasts and Media
- Avalanche Warnings

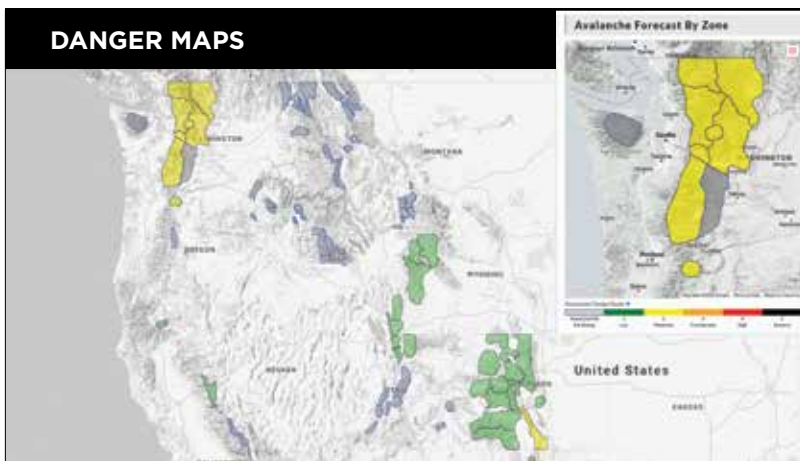
These platforms are available to any AC that needs them. Services are contracted annually at the following pricing structure; costs may change year-to-year, but keeping costs affordable for centers is a priority.

1. **Avalanche.org Listing and Support**—\$250
2. **Avalanche Danger Map Platform**—\$125
3. **Avalanche Warning Platform**—\$125
4. **Weather Station Platform**—One time \$500 set-up, \$500 thereafter.
5. **Avalanche Forecast Platform**—\$750-2500 based on AC size / needs.

The ultimate goal is to increase quality in an efficient, cost-effective manner. Annual fees are closely matched to the annual costs needed to maintain the systems. Project and development costs are currently covered by the NAC and ACs who choose to contribute project dollars. In the future, sponsorship dollars raised by A3 will be an important part of maintaining a sustainable service.



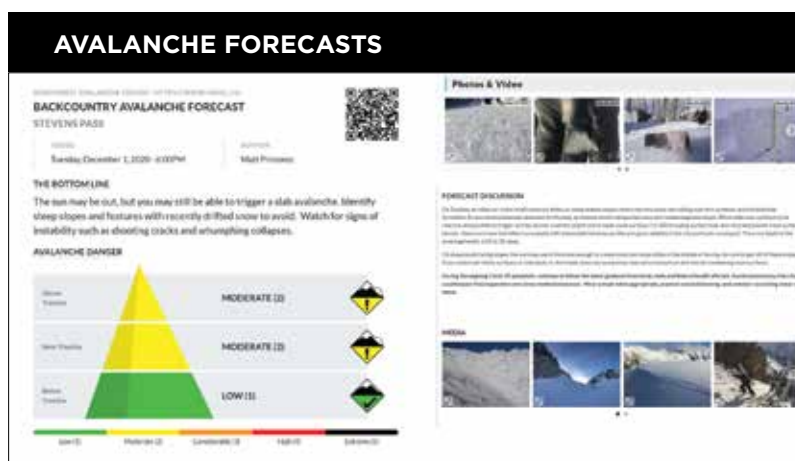
The Weather Station Platform collates data from available weather stations and webcams. It produces maps, tables, and graphs specific to each Center.



The national danger map and the AC homepage map are produced by Avalanche.org. ACs who don't use the homepage map on their website provide data to populate the National Map.

For reference, platform maintenance costs for the 20–21 season were ~25k, ACs covered ¾ of this and USDA FS funds covered the remainder. Development of the Forecast Platform cost ~100k, ½ of which was paid for by the Northwest, Sawtooth, and Sierra ACs, with the remainder as a combination of NAC salary and USDA FS funding.

There are a few things to note about these new platforms. First, the public-facing side of Avalanche.org pushes users to local AC websites instead of keeping users onsite. This allows individual ACs to control their safety messaging and track users. Second, ACs are free to choose the platforms they want and not pay for tools they don't use. Third, all products are designed by collaborative AC working groups. Fourth, small centers get the same service as larger centers for less money, which allows cash-strapped operations



The Avalanche Forecasting Platform, launched last season, is increasing consistency in US avalanche forecasts and will be used by 14 centers for the 21/22 season.

to put their resources into forecasting. Finally, these efforts are creating a central repository and distribution point for US Avalanche Center data that is currently being utilized by companies like CalTopo and OnX Maps. This repository will become increasingly important as third party applications build systems that can utilize our ability to collect and distribute data.

Although our current focus is to optimize existing systems, we are considering future development of an Observation and Accident Reporting Platform. We are committed to strong partnerships with all US Avalanche Centers and are actively working on cross-border issues with Avalanche Canada and Simon Fraser University. Although we have lots of work to do, the structures are in place to facilitate the production of public avalanche information at multiple scales. For more information contact simon.trautman@usda.gov.



AVALANCHE.ORG



PUBLIC WEBSITE

AC DASHBOARD

MAPS

AC LINKS

MAPS

WARNINGS

ACCIDENTS

EDUCATION

WX STATIONS

FORECASTS

The Avalanche.org domain is used as a focal point for both the public website and backend avalanche forecasting tools.



SIMON TRAUTMAN works for the National Avalanche Center and lives in Bellingham, Washington. He grew up in Wyoming, spent some time in the Navy, ski patrolled in Montana, and forecasted for the Colorado Avalanche Information Center, the Sawtooth Avalanche Center, and the Northwest Avalanche Center. Outside of work, you'll find Simon trying to keep up with his daughter or on his boat.

The Tempter in Telluride. NICK DIGIACOMO



PROGRAM HIGHLIGHTS

- **Avalanche.org links users to local AC websites**
- **Products are designed by AC working groups**
- **ACs only use the products/tools they need**
- **Annual fees are matched to maintenance costs**
- **Small centers pay less than large centers**
- **Forms a central repository for US Avy Center Data**

Thanks to all of the Avalanche Center and A3 personnel who worked on this initiative over the last five years. Also, special thanks to the Northwest, Sawtooth, and Sierra Avalanche Centers for going above and beyond to donate time, technology, and funds.

Be Searchable

2021 SNOW & AVALANCHE WORKSHOPS

Connect with other industry professionals and stay current with snow study and forecasting topics by attending a regional Snow and Avalanche Workshop. The 2021 season's schedule is below:

EVENT // LOCATION	ORGANIZATION	DATE
Four Corners SAW // Silverton	Silverton Avalanche School	October 9th
Northwest SAW // Virtual	Northwest Avalanche Center (NWAC)	October 13, 18, & 20th
Colorado SAW // Virtual	Friends of the Colorado Avalanche Information Center (CAIC)	October 14–15th
Wyoming SAW // Jackson	Teton County SAR	October 22–23rd
Eastern SAW // Virtual	White Mountain Avalanche Education Foundation	October 26–28th
MSU SAW // Bozeman	Montana State University	November 4th
Utah SAW // Virtual	Utah Avalanche Center (UAC)	November 5th
Northern Rockies SAW // Virtual	Friends of the Flathead Avalanche Center (FAC)	November 11, 13th
Southcentral Alaska AW // Anchorage	Chugach National Forest Avalanche Info Center (CNFAIC)	November 12th
Bend SAW // Virtual	Central Oregon Avalanche Center (COAC)	November 13th

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PROSAW FROM THE UAC

Please join us **Friday November 5th, 2021** from 08:30–17:00 for the Utah Avalanche Center's 14th annual PROSAW, a professional development avalanche workshop, designed specifically for people who work on snow. Whether you're a patroller, guide, or forecaster, this all-day workshop has got you covered. From continuing avalanche education and risk reduction to lessons learned from generations of professional avalanche workers, PROSAW is delivered in the spirit of theory and practice.



Presenters will include patrollers, backcountry guides and forecasters, highway forecasters, SAR personnel, snow scientists, researchers, and more. The fluid, quick moving format is 15-minute presentations followed by five minutes of Q&A.

PROSAW is an all-day, two-part workshop and everyone is invited to join for both sessions. While the morning is geared towards Utah-specific presentations, there's enough cross-pollinated information delivered that people from all regions can learn something from the diverse stories told. We switch gears in the afternoon to a nationwide format where we address lessons learned and operational changes implemented from the stories told.

Part 1: Lessons learned from past generations and the Utah 2020–2021 season

Part 1 sessions run from 8:30–12:15

Part 2: A collective nationwide approach to how we can learn from one another

Part 2 sessions run from 13:00–17:00

- For registration and group rate questions please contact chad@utahavalanchecenter.org
- For workshop questions please contact craig@utahavalanchecenter.org
- \$25.00 buys this all-day avalanche workshop
- For a detailed presentation schedule and to register, visit the Utah Avalanche Center's PROSAW registration page: <https://store.utahavalanchecenter.org/products/14th-annual-utah-snow-and-avalanche-workshop-usaw-professional-session>

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NWAC WOMEN'S PRO PROGRAM

BY CHARLOTTE GUARD

At the Northwest Avalanche Center we run all our education programs and initiatives through the lens of addressing unmet needs in our community. We consider the deficit of women working in snow and avalanche industry to be a need we have the ability to address. Across ski patrol, DOT, certified mountain guides, educators, and forecasters between 4–24% of professionals are women. Mentorship has been recognized as an important and necessary pathway to development in any high-risk work environment, and historically men have benefited from mentorship, most often through organic relationships. NWAC has developed three unique, but intersecting programs designed to support women working in, or hoping to work in, avalanche professions. We recognize that structured mentorship programs cannot address all barriers, but believe it is a step in the right direction and that NWAC is well positioned to facilitate mentorship nationally.

In 2019 we launched the Women's Mentorship Program to provide concrete steps for women towards professional development. The program integrated with our existing SheJumps collaboration to provide free AIARE L1s to women with spots earmarked for women of color. The Mentees participate in a weekend long training, assist in the AIARE L1s, shadow professionals in the field, and teach NWAC education programs. We work with the participants year over year to connect them to professionals from different sectors, teach NWAC programs, or offer advice and support for career pathways. The program is designed not just to connect women to their instructors but also to each other. As 2019 participant Amber Smith put it, "I've seen the tiers of mentorship in this program, I'm learning so much from our instructors...and then meanwhile there are women in this course who I can help reach their goals too." Over the past two years, nine women have completed the program and eight are currently working either full or part time in the industry.

The Women's Mentorship Program is part of the long game and success will be determined by participants gaining experience and becoming

mentors themselves. Yet in the short term the program is high-touch and inherently limited with far more applicants than we can incorporate. In the spring of 2021, we ran the first national Women's Professional Workshop facilitated by 26 seasoned professionals and attended by 108 participants from across the US and Canada. The three-hour Zoom event featured a panel, breakout sessions, and wrap-up talk. The panel, moderated by Sheldon Kerr, and the wrap-up talk, delivered by Margaret Wheeler, provided valuable insights and hilarity, but the bulk of the time was devoted to small breakout of participants and facilitators. The breakout rooms were divided by location and sector and kept small, so all participants had a chance to ask questions and interact with the facilitators. The result was more enthusiasm and positivity than any other program in NWAC's history.

The Women's Professional Workshop offered something for everyone regardless of your trajectory, skill level, or industry experience. Women shared their frustrations and barriers and were able to get feedback on how women who have been in these industries for decades dealt with the same issues. Some barriers are overt, including the boys' club mentality and leadership that is unresponsive to change. However, some challenges may appear to favor women (men carrying heavier loads or giving softer feedback) but ultimately stunt women's careers. Many of the named hurdles impact men and women alike - most notably dismal compensation for jobs that require you to take on immense responsibility and risk while at the same time demanding peak physical and mental performance. For some of these issues women walked away with new tools, connections, and vocabulary to address challenging environments, and in other instances simply being heard created a needed feeling of solidarity.

We envisioned this event to support women looking to get into the industry; the enthusiasm from the new and seasoned alike was a powerful motivator for even those who have been in the industry for decades. The Women's Professional Workshop provided a space for women in the industry to reconnect with peers, meet potential new colleagues or connections, and make a direct impact to newer faces by sharing their experiences. The final minutes of the event were a rapid-fire comments stream of enthusiasm and motivation to create more equitable spaces in this industry.

To harness the momentum, in the 2021 season we are building on the Pro Workshop by formalizing the breakout room structure into monthly working groups, again hosted by established professionals who can support those just beginning. The Women's Professional Working Groups will encourage not only mentorship but also 'friend-torship' among the participants in each group. The goal for the working groups is primarily to solidify connections and increase networks nationally, but also to make space for some of the excitement and solidarity we saw in the Women's Professional Workshop. We know that mentorship is just one piece to the puzzle, yet we believe it is an important component to real change and bringing more women into the snow and avalanche professions.

If you are interested in participating in any of our programming, please reach out to me at charlotte@nwac.us. Applications for the Women's Mentorship Program will open in October 2021. ●

REFERENCES

<https://theavalanchereview.org/avalanche-professional-demographics/>

You can read more about the Snowpack Scholarship and Women's Mentorship Program at <https://support.nwac.us/snowpack/>.

Benevolent Sexism: https://wp.nyu.edu/steinhardt-appsych_opus/the-role-of-benevolent-sexism-in-gender-inequality/



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CHARLOTTE GUARD is the Program Director at NWAC where she drives education, outreach, and development programming. She has worked to expand educational offerings to include a larger and more diverse audience.

BEACON VOICE COMMANDS

ORTOVOX Aims to Reduce Stress, Improve Outcomes With DIRACT VOICE Transceiver

BY BRIAN HOLCOMBE

Navigating a signal search in rough debris while looking for surface clues.

Distance numbers that are increasing during a coarse search.

Keeping the beacon oriented correctly during the fine search to establish a probe location.

While these challenges are straightforward to us as avalanche professionals, for many recreational backcountry users, the stress of a rescue scenario, especially one involving loved ones and partners, can overwhelm the rescuer. This stress can easily muddle their previous instruction and practice. In 2015, the ORTOVOX hardware team, led by Didi Kotlaba, set out to solve the design challenge of simplifying the search process in order to reduce stress and produce a higher likelihood of positive outcomes.

According to a 2020 survey of backcountry users conducted by ORTOVOX, 45% of respondents reported that their avalanche knowledge was little to none. When an individual is faced with a rescue scenario, there is a good chance they will bring, at best, basic skills to the situation. This can make a stressful event even more so, leading to diminished cognitive performance. According to psychologist Sigrun Holzer at the University of Trier in Trier, Germany, this moment produces a similar chemical reaction to our ancestral need to flee predators.

“Our bodies begin producing hormones such as cortisol and noradrenaline. Blood sugar increases and cells are given a boost of energy,” says Holzer. “At this moment we do need strength, but our brains need to work, too. But our cognitive skills are put on the back burner and targeted action becomes difficult.”

Beacon developers have achieved dramatic innovations over the five decades since Dr. John Lawton created the first analog transceiver. The introduction and widespread adoption of digital interfaces and multiple antennae designs in the 1990s and 2000s were huge leaps forward in the simplification of beacon usage.

However, in the late 2000s we hit an innovation plateau that lasted more than a decade.

Every brand on the market today addresses multiple burials and provides an automatic revert in case of a secondary burial. Ranges have increased to upwards of 80 meters. We can even



check the pulse of a burial victim to aid in triaging. These innovations, however, have made only moderate improvements in the usability of the avalanche transceiver or the likelihood of positive outcomes.

The challenge of creating technology that is of real utility to the greatest number of users is what drove ORTOVOX engineers as we undertook the development of the DIRACT VOICE transceiver.

During the five-year development cycle for DIRACT VOICE, Kotlaba and his transceiver team explored a range of potential solutions. To start, they listened to avalanche educators, guides, and athletes who told us about the difficulties their students and clients encountered when learning to use a beacon. They tested ideas around increasing range and adding features similar to the Barryvox Pulse. They also made real progress with alternatives to the traditional flux-line search. However, when Kotlaba’s team began learning about the power of voice commands, they knew they were on a path that could bring real change to the category.

A large body of research exists regarding human cognitive processing speed and multisensory perception. According to Holzer, by introducing verbal instructions, we can speed up motor execution. These small gains have the potential to significantly reduce stress during a search.

“Visual information needs to be processed first and then translated into an action,” says Holzer. “When this is done for us by a voice and the instructions are direct, we save ourselves one step in

the processing sequence. Thus, clear instructions mean we need less cognitive capacity, which is already limited in such a situation.”

Adding voice navigation to the DIRACT VOICE introduced novel challenges for the team, including identifying the support needed in each search phase, creating easy-to-understand verbal commands, and determining the precise timing of their delivery. For instance, engineers iterated for months on how the timing and cadence of instructions should differ between the coarse and fine search phases.

“We discovered that coarse search instructions should for the most part be corrective, which is why the commands, ‘Keep right,’ or, ‘Turn around,’ are only triggered if the rescuer strays from the flux line. The slower speeds of the fine search allow us to provide more proactive guidance, such as the instructions, ‘Go down to the snow surface and search the lowest value,’” says Kotlaba.

Just as important as the content of the voice commands was the tone. In the DIRACT VOICE, ORTOVOX decided to utilize the same calming voice found in Automated External Defibrillators (AEDs), there to remind users of the techniques they need to conduct an effective rescue when their partner’s life depends on it.

Jeff Hambelton is a Washington-based AIARE instructor and the organization’s motorized program director. Hambelton has spent time testing the DIRACT VOICE in the field and intends to introduce the beacon to his courses this winter.

“In the act of rescue, verbal prompts ease stress and help the rescuer anticipate next steps,” says Hambelton. “Instructors will immediately see the strengths of the device’s coaching, improving the effectiveness and durability of lessons for their students.”

The ORTOVOX DIRACT VOICE avalanche transceiver will be available this winter and retails for \$380. For more information contact info-usa@ortovox.com. ●



METAMORPHISM

AIARE NEWS

AIARE has added several new faces to its team this season—new to AIARE, that is, but not to the avalanche community. **STEVE CONGER** has stepped into the role of Technical Director, and we are thrilled to have his cross-discipline, multi-sector experience in both the US and Canada to develop and further industry best practices and standards. Steve studied under Dave McClung to earn his Master of Science on practical application of technology in a forecasting environment with the Avalanche Research Group at UBC. His regular contributions to ISSWs and to this publication (he’s also an editor emeritus) have made Steve an invaluable member of this community, and we’re thrilled to have him providing technical leadership in AIARE’s role as a curricular and training organization.

Also joining the team is **EMMA WALKER**, another regular TAR contributor. Emma joins us as the Curriculum Manager, a brand-new position for AIARE. She’ll be responsible for managing and updating recreational curriculum like the AIARE fieldbook and online learning content, as well as enhancing AIARE’s education communications and support for instructor training and continuing education. She holds a Master’s degree in outdoor and environmental education from Alaska Pacific University, where she completed her thesis research on decision-making dynamics among Denali guides.

Our new Member Services Manager, **SARAH MACGREGOR**, has already become the backbone of day-to-day communications and office operations at AIARE, a position she took over from long-time AIARE employee Don Sveta after his retirement this summer. Sarah is the first female AMGA-trained splitboard guide in Colorado and is actively working to add more women to that list by reaching women’s-specific programs and workshops. She’s also an AIARE instructor and spends her off time playing hide-and-seek with her dog, Fawkes, who’s in training as an avalanche rescue dog. AIARE is grateful to add these folks, with their diverse skills and experiences, to our staff. We look forward to their contributions to AIARE’s mission this season and beyond! ●



UPDATE FROM BEARTOOTH POWDER GUIDES

REED YOUNGBAR became half owner of Beartooth Powder Guides (BPG) in April of this year. After 10 seasons in business, founder and lead guide **BEN ZAVORA** decided that, in order to continue to offer the quality boutique guiding and hut experience that BPG has become known for, it was necessary to take on a partner. Reed started out as a client of BPG in 2013 and returned each year for a guided trip, avalanche class, or ski mountaineering camp. Reed fell in love with Cooke City and started working for BPG in 2019. Reed brings a strong work ethic, positive attitude, and diversity to our guide team with his skills and enthusiasm in the splitboard realm. ●



BACKCOUNTRY NAVIGATION

BY DAVE MATHES

For the last few years, I have been instructing avalanche classes for the US Military, and I found that students picked up the material but were sorely lacking an ability to translate the theory into practice of planning a day out in the winter. So I created Backcountry Nav, **an online course that teaches anyone going into avalanche terrain how to create route plans, perform terrain analysis, and use military-style navigating techniques.** The mission is to reduce avalanche-related deaths, enable individuals to stop blindly following, and provide a platform for communication. The methods and workflow come from a special forces search and rescue background where there is no room for error or mistakes.

In a Zoom classroom setting, students are empowered to make the routes, plan their adventures, analyze the terrain, and go through a checklist. No more hands-off training. No more chasing the title of “experienced” and going into terrain without proper planning. No more following someone just because they have been there before.

It is 2021, and there are fantastic tools out there to help keep you safe in the alpine. With so many options for different apps and programs, this course highlights the pros, the cons, and dives deep into their powerful features.

Learn more at www.backcountrynav.com ●



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LIVES WELL LIVED:

ON MARCH 27, 2021, THE SNOW INDUSTRY WAS LEFT REELING AS NEWS SPREAD OF THE LOSS OF FOUR PHENOMENAL HUMANS. GREG HARMS, 52, PASSED DOING WHAT HE LOVED MOST WHEN A HELICOPTER CARRYING HIM, FELLOW GUIDE SEAN MCMANAMY, 38, A PILOT, AND TWO SKI GUESTS CRASHED IN THE MOUNTAINS OF ALASKA.

GREG HARMS

PASSIONATE POWDER-CHASER AND MASTER OF LIVING IN THE MOMENT

STORY AND PHOTO BY BRAD COSGROVE



Greg is survived by his immediate family including his mother and father and his partner Chantel and daughter Freja.

Greg was born in 1969 in the Pacific Northwest, where his life of chasing snow began while free skiing and ski racing at Mt. Hood. His professional career as a skier started at Mt. Hood Meadows where he began as a ski instructor. As an instructor, Greg spent a winter in the Pyrenees mountains teaching the King of Spain and in Aspen, CO, teaching NBA star Michael Jordan. His success as a ski instructor went far beyond that both geographically and temporally as he never stopped teaching people to ride.

After high school, Greg spent several seasons in Tahoe during the storied winters of the 90s. This is where he sealed his passion for free skiing and began to follow his dream of chasing powder year-round. His first year-round winters were spent in Portillo, Chile as a ski instructor and he started as a heli-ski guiding in 1994. In 1997, Frank Coffey came to Portillo to “run the show.” It happened to be a record winter and upon arrival Frank heard that someone had flashed a piece of closed terrain called the Gargantia Chute. When he asked who it was the answer was “That’s Greg Harms...one of your heli-ski guides.” Upon meeting Greg, he found himself standing chest-high to a guy whose torso was the shape and size of a fuel barrel. Harms looked down and, with classic Harms charm, said, “Nice to meet you, boss,” with a grin on his face.

In the 90s Greg started to spend his winters in Aspen, Colorado, where he went on to establish himself as a true force in international ski guiding, and in 2003, began to work as a heli-ski guide in Alaska. When Greg began taking his clientele to the various operations in South America, Alaska, Iceland, Canada, and beyond, his heli-ski brokerage Third Edge Heli really took off.

Greg was also a founding member of Tordrillo Mountain Lodge and ran his own operation based out of Santiago, Chile. He also worked as a guide for, and would bring groups to, many other

operators not just in Alaska but around the world. Most recently, he launched his own operation in Alaska to great initial success.

Greg was a ski guide who craved seamless days pursuing his passion in remote places with people he considered to be his friends. Greg could be described as memorable, funny, caring, inspiring and of course, BIG! His presence loomed large, and his magnetism always drew people in. When you had his attention, you had all of it. Those who loved him called that being “in Harms’ way.”

He was a master of living in the moment, and that energy was contagious to say the least. His background of being a very accomplished ski instructor as well as ski guide allowed him to easily show people of varying riding abilities the art of mountain travel. He could give people a sense of accomplishment and help them improve their ability to ride and to read wild snow. He would adapt to the guest easily because he was their friend and took the time to understand their individual needs while still pushing them to break through to new horizons.

One could write a book about all Greg’s different exploits in the mountains. First descents, opening new areas, countless huge days shredding in perfect conditions, après antics...The motto was “must be present to win” and Greg was-and did. He once did 100 different backcountry runs in a 24-hour period in Alaska with two good friends.

To the field of ski guiding, he leaves a fresh perspective as a mentor to many; Greg focused on the interpersonal skills that are not always addressed in guide training courses. That continued focus on the needs of individual clients and providing them the tools they need to achieve their best day ever in the mountains is a skillset that those who worked and played with him will carry forward forever. This came easy to Greg, and he remains an inspiration to some of the top guides in the heli-ski industry.

Greg truly lived the dream and was literally able to turn that dream into a full-time job. This worked well for him because he didn’t view it as work but as his passion.

He was not only the pioneer of an immense amount of terrain in Alaska and Chile but was also a pioneer of new ways of approaching a day of heli-skiing with a focus on the guest’s experience. If you were able to ask him what accomplishment he was the proudest of, his answer would be the immense amount of quality relationships he established with others while doing what he loved. Greg has SO many friends and he impacted so many people’s lives in a positive and memorable way. He was a master of stoke and accepting of everyone. He led the way by showing others how to pursue their passions, regardless of the obstacles. He helped people believe in themselves. He made his coworkers’ and guests’ and friends’ mountain dreams become realities beyond what they could have imagined. Greg Harms is a legend and lived like one. ●

SEAN MCMANAMY

PROFESSIONAL GRAVITY SURFER, EDUCATOR, GUIDE, AND FUN-HOG

BY BROOKE EDWARDS



October 2019, Grand Canyon ■ BEN STURGULEWSKI

Sean McManamy’s childlike joy and buoyant smile always made it tough to have a bad day in his presence. Growing up in New Hampshire, there was only one magnet on the family fridge. On it, a quote from Abraham Lincoln: “Whatever you are, be a good one.” Of the hundreds of stories that friends have shared with his mother Barbara since the accident, she relates that all spoke to his consistency of character: a human being of remarkable presence, hilarity, and as a fun-loving supportive friend, brother, son, and husband. He lived up to that magnet. Sean left a legacy in the guiding and educating world. He had lived more lives in 38 years than most people do in 90.

Sean’s mom recalls his first time on skis: (Mickey Mouse K2’s at Jiminy Peak): “*Sean screamed so loudly that he rattled the plate glass lodge window. ‘I hate skiing!’ he bellowed repeatedly. ‘We are getting on the chair lift,’ I said in the Calm Mom Voice. Miffed, he finally went with me. The rest is history, as they say.*”

After loving his Outward Bound course on Backcountry Snowboarding in the Rockies, Sean made the move from New England to attend college at Colorado Mountain College. Yet, soon his interest in snow developed into one that could be better accommodated in Alaska, so he transferred to Alaska Pacific University where he met long time mentor and professor Eeva Latusuo. At APU he found mountaineering, snow science, and Caitlin Hague; an accomplished athlete, mountaineer, snow scientist, and heli-ski guide herself. The couple soon found themselves immersed in a decade of adventure that took them all over the world enjoying surfing, skiing, and broadening their depths of knowledge in their professions. They were together for 16 years, married for two. Throughout it all, they made things work in a minuscule studio, causing Sean to dub their space #oneroomone love.

I asked Eeva how she remembers Sean:

“*When Sean showed up north to study Outdoor Studies and Snow Science at APU, he was full of*

Mourning the loss of friends

energy and excitement. Initially it was about snowboarding his brains out, but soon enough he committed to academic interests - maybe even surprising himself on how adept he was at finding answers to snow-related questions. One of his academic highlights was sharing his undergraduate thesis (applying the Canadian avalanche terrain exposure scale to Turnagain Pass) at ISSW Anchorage in 2012. I knew he was committed to becoming an avalanche professional when he switched his snowboard to skis to travel more efficiently in the backcountry. Even as a heli-ski guide he would go between one or two boards on his feet, yet regardless of travel mode, his joy about the movement stayed off the charts.

Sean was tall, charismatic, and most of the time laughing loudly with the world. I remember teaching a winter wilderness travel course with him in the middle of a cold dark Alaskan January. After a demanding day of getting novice students on their skis pulling sleds from A to B, we finished the day cooking a tasty meal in the snow kitchen sharing stories and jokes, laughter lasting till sleep silenced the chilly tent. He loved snow and sharing its shiny and dark secrets with people around him - that joy was contagious. Thanks for all the stoke, Sean."

Sean was a powerful and supportive advocate for women in the male-dominated fields of snow science, mountaineering, and heli-ski guiding. In these fields where women traditionally have been asked to be twice as good as men before getting respect, Sean took great care to highlight their skill and prowess in the mountains and the snow, creating a spotlight for women that helped lift them up. I know many female colleagues of his who are incredibly grateful for his allyship. He created a safe emotional space for women to succeed in and that was truly a gift to those of us working alongside him in very male-dominated spaces.

At the Alaska Avalanche School, Sean welcomed new instructors, helping coach them on the intimidating task of building personal PowerPoints. I was one of these newbies that he chose to share his lectures with until I could work towards building my own. His knack for humor integrated with learning made students in his avalanche courses feel as if they had front row tickets to Comedy Central; yet they came away with a deeper understanding and an ingrained booming fake professor voice on repeat in their heads: "If snow is your problem, terrain is your answer..." And "Slow is smoooooth, Smoooooth is fast." His legacy made us all better instructors, striving to engage our audience through humor and an interactive classroom that left no one snoring through crystals and snowpack diatribe. His guiding style resounded with this same ability to ease people's fear, stress, and insecurities by breaking the tension with levity. His childlike excitement was contagious to all who engaged with him, leaving them marked by his joy and paying it forward in their daily interaction with others.

His mom sums it up: "Sean never romanticized the risks of being in the mountains. For Sean, the potential for sacred, transcendental moments lived side-by-side with the potential for avalanche,

an unseen crevasse, and a fall. When a friend or colleague died in the field, Sean reacted when he heard people saying that it was easier to bear because they died doing what they loved. He said in his clear and realistic voice "No one I know wants to die, doing what they love or otherwise. We all want to go home." His work and play in the field were governed by this perspective. His job on any given day was to keep himself and others safe, while pushing forward to experience the magic that only the mountains and snow offer.

In the words of Bishop Shelby Spong: "To commit to living as the very sun itself lives, that is, to do what you were created to do, to shine and shine without regard for recognition or permanence or reward, to love and simply be for the sake of loving and living and being." Sean McNamamy succeeded in this better than most humans I have ever met.

Donations can be made in his memory to Alaska Avalanche School, Protect Our Winters, and YMCA Camp Belknap. ●

MIKE WIEGELE

HELI-SKIING LEGEND, RESEARCHER, AND EQUIPMENT DEVELOPER

BY HALSTED "HACKSAW" MORRIS
CONTRIBUTIONS BY BRUCE JAMIESON



Helicopter skiing legend and avalanche research promoter Mike Wiegele died on July 15th at the age of 82. Mike was a dear longtime friend of mine. Sitting down at the keyboard to write this obituary I can't help but think of all the great times skiing and talking we had together.

Mike grew up in Corinthia, Austria in a humble farm family. He immigrated to Canada in 1959. Mike's passion for skiing eventually led him to British Columbia where he started Mike Wiegele Helicopter Skiing (MWHS) in Valemount BC, in 1970. Eventually he moved his operation to Blue River BC, whereas he loved to repeat a quote from a longtime Blue River resident, "Snowflakes fall down big and straight." In Blue River, between the Cariboo and Monashee ranges, Mike found his powder paradise. MWHS is now the largest single-based heli-ski operation in the world and has been in operation for fifty years. People have often argued about who was the inventor of heli-skiing. Mike never claimed to have invented heli-skiing, but Mike and Hans Gmoser (CMH) both deserve

credit for being the first to create and evolve the "helicopter skiing vacation package" into what it is today.

Mike was very involved in the development of many ski and avalanche-related pieces of equipment and procedures, but he will mainly be remembered for his interest in avalanche research. There is hardly an ISSW proceedings that doesn't have multiple research papers that cite MWHS as a major research supporter.

I asked Dr. Bruce Jamieson to sum up his research program that Mike supported:

"At a 1987 avalanche conference in Edmonton, Mike Wiegele (a legend to me), approached Colin Johnston and myself. He was keen on starting avalanche research in his helicopter skiing operation in Blue River, BC. Colin said government funding would be difficult without an industrial partner (and cash). Mike's enthusiasm for avalanche research made the ASARC program happen. Within a couple of years, the other Canadian helicopter and snowcat skiing companies and 22 ski areas started to support the research. The ASARC program grew to include another field station in the Bobby Burns and then Rogers Pass.

By the time the program wound down in 2014, 25 graduate students and over 40 research technicians had done over 6000 person-days of field measurements, shoveled over 8000 tons of snow, (not including shoveling to extricate stuck snowmobiles), observed over 5000 snow profiles, done more than 20,000 snowpack tests, and ate more than 10,000 chocolate bars.

In Blue River, Mike insisted the research technicians and graduate students attend the morning guides' meetings and report their findings at the evening meeting. This required that they really understand the questions the guides had about the snowpack and resulted in practical research results.

Starting around 2004, Mike would invite several international researchers to ski for a week late in the winter. They were happy to "sing for their supper" by sharing their research results with the guides. The fortunate researchers included Dave McClung, Sam Colbeck, Ian McCammon, Ross Purves, Jürg Schweizer, Colin Johnston, Karl Birkeland, Pascal Haegeli, Charles Fierz, and me (Bruce Jamieson). After the ASARC program wound down in 2014, Mike continued to invite researchers to ski and exchange ideas with the guides.

Many of the research technicians and graduate students have gone on to careers in guiding, managing avalanche operations, avalanche consulting, engineering and research in North America and Europe. Mike Wiegele's enthusiasm and drive for applied avalanche research have benefited so many avalanche practitioners and recreationists around the world."

The backcountry community worldwide is forever deeply indebted to Mike for all of his longtime research support. He was just happy that his support was going to benefit so many folks. Mike was a humble guy who will be deeply missed. He touched many lives and brought a lot of joy to the world.

Mike will be forever remembered for his favorite saying, "Let's go skiing." ●

HAVE WE LOST OUR WAY?

We've lost our way with backcountry messaging.



Early last year I was very lucky to capture an avalanche in motion on Mount Shuksan while my camera was on the tripod. Photo Sergio Ripa of Bellingham, WA

We Have a Problem

BY PETE EARLE

often than not, Dad held the gate open for the wife and kids.
 What do we do? Chalk it up to Darwin and natural selection? Tell that to the husbands and wives, let alone the children of those who died. Tell that to the paddlers and SAR responders who attempted CPR on the one-hour burial and who were exposed to the elevated risk of a backcountry rescue/recovery. No one is winning here.
 Erect memorials to former victims? Grizzly photos showing victims in burial positions—that'll change their minds, right? That strategy certainly attempts to solve the empathy gap, but in this case that gap is a mile wide. These folks don't even realize what they're doing is unsafe.
 Tap the local backcountry community? Encourage and enable peers to educate the fish out of water? That's great until frustration issues and discussions morph to insults and "purr" calms.
 How about a transceiver/drover/probe to exist? That's a start, and at least they're searchable for the patrol/SAR team. They can leave their dogs and probe lines within the resort where they belong. Whose responsibility is that? Patrol has a full-time job managing the resort that's paying them to keep guests safe. There are hundreds of users using the out gate every weekend, better hire a few more paddlers for the backcountry, that's the point.
 Move the gate somewhere else? Make it a longer hike? There are sidepaths along the whole ridge, nowhere is free from danger. If the gate moves lower, folks will put in a traverse at mid-slope instead of upper-slope. Might be more dangerous in the end.
 Remove the gate? Hell no. That's public land and I have every right to access it. It's not my fault that folks who didn't know better died! That's the only non-private backcountry access for thirty miles. Don't panic at first the actions of a few! An empathy aside, there are enough backcountry access issues, let's not voluntarily create more.
 At this point I'm asking for help. What changes or messaging has worked for you or your resort? What hasn't? Please reach out to pete@heliskihistory.com if you have possible solutions. Just under half of the avalanche fatalities in Utah since 99/00 have been from resort access users. That's 17/37 if you're counting at home. Over half of those (9) happened in a former resort. We can't do much worse, how can we do better? 🙏

We can't do much worse, how can we do better?

BY TED STEINER

In regards to Pete Earle's article, "We've Lost Our Way with Backcountry Messaging. We Can't Do Much Worse How Can We Do Better? ... We Have a Problem," TAR 39.4.

First, it is well established that current avalanche safety messaging products (messaging) provide critical data describing avalanche, snowpack and weather. In turn, this data assists a substantial number of backcountry travelers each winter season with reducing uncertainty while fortifying decisions related to terrain choices. Current messaging also provides a solid platform for conveying data related to avalanche accidents and, through reporting, details of accident(s). Although sometimes tragic, information provided in accident report(s) consists of objective-based information to educate and assist others with avoiding accidents.

In my opinion, all this information in messaging is solid, and we're fortunate to have it conveyed to us, professionals and public, through the backcountry avalanche forecasting network in the US.

Secondly, and in regards to "We Can't Do Much Worse, How Can We Do Better?" Avalanche professionals both nationally and internationally have been holistically focused on modifying, updating, and creating messaging products with consistency in application, appearance, and verbiage. A good example of this, which is relatively recent, was collaboration between US and Canada avalanche professionals in the North American Avalanche Danger Scale. In the US, the National Avalanche Center is continually striving to improve messaging products as well as platforms that provide

consistency in presentation as well as objective information for professional and public dissemination. On a local level, at least from what I have observed, have read about, or seen presented, avalanche center directors, forecasters, and associated non-profit boards have been dedicated to improving messaging products for the benefit of professional and public users.

I would also like to point out that, although I haven't read all this season's accident reports, in the accident reports I have read, the messaging related to backcountry forecast(s) was CLEAR. It was ultimately the choice (decision) and action(s) of the individual(s), whether based on perceived risk or actual risk (evaluated conditions and data), that ultimately led to each of those accidents.

As such, in my opinion we haven't lost our way. On the contrary, messaging is clear and concise. What I believe needs to continue being the focus, and it's nothing new, is education. Education available to those that want to learn about messaging, education to those with problematic snow-safety ethics, and continuing education for those that want to reinforce established skill-sets. If you choose to travel in avalanche-prone terrain, the more educated you are as a user group, the greater your chances are of steering clear of snakes and dragons.

Bottom line, education is THE KEY to clear messaging because regardless of what the message is, if you're not educated in what the message is conveying, it's impossible to understand it.

No We Haven't

BY CHRIS LUNDY

We haven't "lost our way with backcountry messaging." Although Pete Earle's article (TAR 39.4) made some good points, I found statements such as "We can't do much worse" offensive. Last winter's record number of avalanche fatalities is not the fault of forecasters, educators, or other avy pros. We do a damn good job. The avalanche community draws a remarkably talented, passionate, intelligent, and diverse pool of workers. Of course, we should always strive to do better, and I believe we do. But we are not the problem.

People are the problem, and rather than take the blame and burden upon ourselves because we failed to save their lives, the backcountry public needs to take responsibility for their actions. In the case of the Wilson Glade accident, when multiple people are on a slope that is capable of avalanching when the danger is rated High, clearly the messaging wasn't the problem. There are many reasons why people put themselves in dicey situations. Decision-making error is one we focus on all the time. But I think a major driver is our



attitude towards risk in both the sport of backcountry skiing/riding and as a larger culture.

Long story short, I believe that most backcountry users are taking too much risk—and likely don't realize it.

I think the avy community should work to foster a culture of less risk-taking. What if we teach that on any given day, our default terrain choice is non-avalanche terrain? Only when factors clearly point to good stability do we consider stepping out. I think many folks—both rec and pro—default to consequential avalanche terrain unless it's obvious they should step back. It's a subtle but important difference, a mindset that is more likely to keep you alive.

Also, we usually teach risk in the context of a day's decision-making, but really, it's cumulative and adds up over the life of a backcountry rider. A lifetime of "I'm pretty sure this slope is good to go" will be a short one. You need to be really sure—as in really f*!\$#ing sure. In this approach, managing uncertainty is simpl(er)—if there's much at all, we stick with our default (mellow terrain). We need to teach the "long game" and focus on an acceptable level of risk that is likely to keep us alive not just for the day, but for a lifetime of days.

I can almost hear readers groaning. "He wants us to ski/ride OGP (old guy/gal powder) 95% of the time! He doesn't understand it's a personal decision, and that the risk is worth it to me for the incredible reward of riding the steeps." I used to think risk was a personal thing too, but I've changed my tune. Everyone has family and friends that will suffer from their death. We need to help others understand that taking excessive risk affects folks they may not think of—rescuers, the instructor that taught their Level 1, the avy community at large. This last issue of TAR was a great example of the ripple effect these tragedies have on all of us.

Which brings us to risk tolerance—a concept I encourage the avalanche community to revisit. If you take 10 backcountry users, all with different proclaimed "risk tolerances," bury them in an avalanche, and ask them what they're thinking as they face the possibility of death, I'd wager that 9.5 of those people would say that run/ride wasn't worth it and they'd do it differently if they could. I think the concept of risk tolerance (which probably came from the economic sector where lives aren't on the line) may enable excessive risk-taking by saying it's ok to take risks, as long as it's by choice and you accept the consequences. But the risks and consequences of avalanche accidents are too abstract for people to do the math. We need to educate people on what an acceptable level of risk is, not expect them to figure it out on their own.

I am aware this is an uphill battle—because as a culture we glorify risk. If you take risks and succeed, you're a hero; if you take a risk and lose, you're a zero. In classic U.S. fashion, we glorify risk then scream that something needs to be done when someone dies taking a risk. We can't have our cake and eat it too. Social media perpetuates this problem, but calling someone out for taking excessive risk (even if they got away with it) is quickly construed as shaming. I'm also not sure how much buy-in this idea will get from the avalanche community at large, since many of us avy pros take excessive risks too, whether on personal days or even while on the clock. For the backcountry public to take us seriously, we must lead by example.

A more tangible thing we can do—which won't solve the problem, but will help us cope with it as forecasters and educators—is to realize that our job ISN'T to save lives. Let that sink in for a minute. Our job is to give people the best tools we possibly can so they can save their own lives, if they so choose. We'll continue to beat ourselves up until we understand the difference.

I believe that most backcountry users are taking too much risk—and likely don't realize it.

A Considered Reply

BY PETE EARLE

The intent of my essay was a call to action and my reference to a specific messaging problem (backcountry exiting from resorts) may have been taken more broadly than I intended. I agree with both of these responses in terms of education and user numbers increasing and that we all face a unique challenge in the changing landscape of backcountry recreation.

To that point, Vail Resorts just announced a permanent closure of the 9990 exit gate in Park City. The decision is understandable when looking through their eyes; however, any loss of access is bad for the backcountry community and could prove to be a slippery slope if deemed the most acceptable solution in other "problematic" zones. I think we all need to work on outside-the-box ideas, not just in messaging, but also how the message is delivered to certain users. Ultimately, the goal of my essay was to broaden the participation beyond avalanche center forecasters who work hard to craft daily advisories that will impact readers. I suspect there are great ideas lurking in guide meetings, patrol shacks, educator debriefs, and around the tailgate after a ski tour, and I would encourage inclusive participation in the discussion. ●



TED STEINER lives in Whitefish, Montana, where he is a longtime A3 member and avalanche forecaster for the BNSF railroad. See a full profile of Ted in TAR, 39.4, where he was honored for his contributions to the avalanche world.



CHRIS LUNDY is heading into his 12th season with the Sawtooth Avalanche Center and was a previous owner of Sawtooth Mountain Guides. He has worked in many aspects of the avalanche industry over the past 20 years, including stints as a researcher, ski patroller, educator, ski guide, web developer, and forecaster. Chris lives in Stanley, Idaho.



PETE EARLE works as a lead instructor for the American Avalanche Institute and as a guide and forecaster for Powderbird Heli-ski. He is hoping to ski avalanche terrain sometime this winter and is sick of being entrenched by Utah's poor snowpack.



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POST-TRAUMATIC

Stress Disorder Prevalence in Recreational and Professional Alpine Sports: a Restrospective Study

BY ERIC HASKELL & DARCY SOLANYK, MS, PA-C

Risk is inherent to alpine sports. Most research regarding accidents and alpine sports has focused on fatal events and in particular, avalanches. These studies are of great importance to us as a community. However, the lack of investigation into less-than-fatal events and into the broader costs of accidents beyond the loss of life leaves room for inquiry.

Misfortunes in the mountains exert both physical and psychological tolls on those involved. A recent study from the Alps followed participants for one season, looking at rates of injuries from ski touring. As a group, participants experienced an average of 2.5 injuries per 1000 hours of skiing. Of those injuries, 7% were classified as severe. Another study looking at the morbidity of winter sports reported a mortality rate of 1.83 per 100,000 alpine ski tourers in the Alps. In addition to physical harm, the loss of a climbing or skiing partner, witnessing a scary accident, suffering a serious injury, or surviving a natural disaster can also lead to psychological harm, including post-traumatic stress disorder (PTSD.) Research investigating alpine sports and PTSD is few and far in between.

Probing inner depths can leave you feeling alone. Here, probing below the Gran Zebbru, Italy.

■ KELLY DOHN

PTSD research is a growing field that began with its inclusion in the Diagnostic and Statistical Manual in 1980. Initial investigation of the condition looked at Vietnam veterans and has expanded over the years to include victims of sexual and violent crimes, natural disasters, and more recently high-risk professions such as fire-fighters and police officers. As our understanding of PTSD expands, it has been found there are many other groups who have increased exposure to trauma and are at risk for PTSD.

PTSD is a disorder that develops in some people after experiencing or witnessing traumatic events. Symptoms of PTSD manifest in four major categories: intrusive symptoms such as flashbacks and nightmares; avoidance symptoms such as resisting certain places and things that remind them of the event; alterations in cognitions and mood, such as the inability to remember an event or distorted beliefs about oneself; and alterations in arousal such as being easily startled or indulging in self-destructive behavior. In addition to these symptoms, the event must cause dysfunction in important aspects of life. PTSD has been linked to increased rates of substance abuse, depression, anxiety, suicidal ideation, and suicidal attempts.

Lifetime prevalence of PTSD has been shown to be around 6.1 percent and has a higher prevalence in certain groups such as survivors of sexual violence, interpersonal violence, exposure to combat, and exposure to other life-threatening traumatic events such as motor vehicle collisions. It is estimated that the prevalence of PTSD in those exposed to life-threatening events is around 12 percent.

Professional guides, rescuers, and avalanche forecasters are a unique subset of alpine sport participants since they expose themselves to the hazards of mountain travel on a regular basis. In addition, they regularly respond to accidents and help with rescue. Their increased exposure to the mountain environment and other party's accidents increase their chances of experiencing physical and psychological trauma. A group of researchers looking at Swiss mountain guides found that on average each guide was exposed to 2-3 traumatic accidents during their career. They assessed participants for symptoms of PTSD in the previous month leading up to the study and found low rates of prevalence of symptoms.

STUDY DESIGN

In this study, an online survey was used to assess participants' relationship to alpine sports, their exposure to accidents, and screen them for PTSD using the Breslau scale, which is simply a screening tool and not diagnostic of PTSD. This study looked at lifetime experience of PTSD symptoms related to accidents during alpine sport activities. Alpine sports included in this study were backcountry skiing, rock climbing, ice climbing, and mountaineering. Professional participants were compared with recreational participants.

TABLE 1: Comparison of Recreational and Professional Alpine Sport Participants, Breslau Screening, Total Participants 327

CATEGORY	NEGATIVE BRESLAU	POSITIVE BRESLAU (NUMBER, % OF TOTAL)
Recreational Alpine Sport Participants	115	7, 5.7%
Professional Alpine Sport Participants	212	48, 18.5%

X2 10.918, p .000958



TABLE 2: Comparison of Professional Subcategories, Breslau Screening, Total Participants 212

CATEGORY	NEGATIVE BRESLAU	POSITIVE BRESLAU (NUMBER, % OF TOTAL)
Guide	125	35, 21.9%
Avalanche Forecaster	43	5, 10.4%
Search and Rescue Member	19	7, 26.9
Climbing Ranger	11	1, 8.3%
Other Professional	14	0, 0%

Fischer-exact test two-sided $p(O \geq E | O \leq E)$: 0.068, $p(O > E | O < E)$: 0.068

For more detailed results, visit <https://www.surveymonkey.com/results/SM-VWYXMP999/>.



RESULTS

- Recreationists reported an average of one life qualifying traumatic event (a positive life qualifying traumatic event was defined as one that resulted in hospitalization, permanent disability, or was fatal)
- Professionals reported an average of two life qualifying traumatic events
- 61.5% of respondents had been injured themselves while participating in alpine sports
- 53% percent of all participants were witness to or have had close contacts involved with fatal accidents in alpine sports
- Both guides and avalanche forecasters had significantly more individuals who experienced four or more life qualifying PTSD events while participating in alpine sports than recreationists and witnessed significantly more fatal accidents or had them occur to close friends
- The most severe accidents experienced first-hand or second-hand occurred while backcountry skiing for all groups except climbing rangers, who experienced the most severe accidents rock-climbing.
- Professional alpine sports participants were found to be 3.2 times more likely to screen positive using Breslau scale than recreational participants
- Experiencing more traumatic events and experiencing more severe accidents were associated with a greater likelihood to screen positive using Breslau scale

WHAT CAN WE LEARN FROM THIS?

Experiencing traumatic events while participating in alpine sports is a common occurrence. The physical cost of such tragedies such as changes to mobility are quickly tangible; the emotional toll can be much more obscure. While the number of backcountry users is skyrocketing, we are still a small community and the effect of serious accidents reverberate through our group. Recognizing these effects in ourselves and our friends is essential to maintaining our well-being.

Stress injuries exist on a continuum from minor to life-debilitating as described by Laura McGladrey. She has created an awesome resource with the help of the American Alpine Club (AAC) for anyone affected by grief and trauma in the mountains. Given the high lifetime incidence of positive PTSD screening in alpine sport professionals, it is recommended that professionals familiarize themselves with ways to recognize that they or a peer may have a stress injury and what resources are available to help them out. The AAC’s grief resources are an awesome tool for all alpine sports participants even though it was built for climbers. It is available at <https://americanalpineclub.org/psych-ed>. Also keep your eye out for the Avalanche Resiliency Project which is in the works.

PTSD is at the severe side of the spectrum. If you believe you may be struggling with severe stress injury or PTSD you should seek the help of a therapist or health care provider experienced in treating PTSD. Restoring health and function in your daily life is possible and essential.

A huge thank you to: all who shared their experiences and participated in this study, and to Mark Payton, PhD, for help with statistical analysis. ●

Practice makes perfect, and practice makes a potentially stressful situation less so. Prepping for the AMGA Aspirant Exam, Thompson Pass, Alaska.

■ ERIC HASKELL

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ERIC HASKELL is a third-year Physician Assistant student at Rocky Vista University. He is also an AIARE instructor with experience guiding human-powered and mechanized skiing.



DARCY SOLANYK, MS, PA-C, received a Master of Science from CSU and her Physician Assistant Certificate from the CU’s Child Health Associate/PA Program in 2007. She practiced in Pediatric Gastroenterology at Children’s Hospital Colorado before transitioning to PA education.

SHORT STACK STRATEGY

BY MIKE AUSTIN

As backcountry skiers we are not as good as we think we are when it comes to making decisions in avalanche terrain. We often misjudge the hazard and overestimate our abilities. We convince ourselves that with training, knowledge, and caution we can minimize our likelihood of an avalanche involvement. Yet every year the statistics of human-involved avalanches clearly does not bear this out. Trained and seasoned professionals constantly get caught in avalanches. Over a five-year period, 18% of avalanche fatalities in Switzerland involved a guided group.*

The question is not whether these experts are well trained...the question is whether the world is unpredictable.

—Kahneman/Tversky

Mark Smith sums it up concisely in his seminal essay *The Big Lie*. He is talking about the wildland firefighting world, but his words apply here as well.

We are not operating in a benign environment where incidents occur as the result of an individual deviance from a prescribed protocol, more we must be conscious that we operate in a high-risk environment where hazard is constantly present and conduct ourselves accordingly.

REPEATED EXPOSURE—MAKING DECISIONS IN THE AGGREGATE

While a single day's exposure to avalanche terrain is considered a very reasonable risk, Kristensen & Genswein's ISSW 2012 presentation on repeating that exposure over a lifetime should have been a wakeup call within the ski guide industry, but we haven't seen that action come to pass. The author and former behavioral scientist Annie Duke is also concerned by repeated exposure and how it can dramatically affect outcomes over time. She uses a donut analogy to illustrate her point: nobody eats a single donut and thinks 'this donut will kill me.' But we know that if you eat enough donuts day after day for 30 years you will get fat and likely suffer a heart



A Poker Strategy for Operating in High Consequence Avalanche Terrain

attack at some point. Whilst this is a different form of repeated exposure to that of avalanche risk (it's an accumulated risk) the point is made that if we do something repeatedly over an extended period of time then it becomes an *unconscious decision in the aggregate*. Pro skiers and ski guides who see themselves as making reasonable choices in their terrain selection run the risk of placing themselves into something altogether more dangerous by *repeating their exposure to the hazard year upon year*. By viewing each decision in isolation, they are in effect subjecting themselves to a normalization of deviance.

According to Kristensen & Genswein, repeated exposure changes a rare and reasonable chance of dying in an avalanche of 1:100,000 for a single day's conservative recreational backcountry skiing (Munter 2008) and extrapolates it to the reality of a 1:20 chance over the career of a ski guide. In any other profession there would be an outcry of such high mortality figures. Clearly our culture is outweighing our current strategy. **It's worth noting that the 1:20 risk of death figure increases further to 1:10 when we operate regularly in complex high consequence terrain on Considerable and High hazard days over a career.**

Due to the function of repeated exposure, it's not enough to simply make good decisions. Making informed rational decisions, following protocols, and semi conservative terrain choices only gets us from Genswein's 1:10 down to a 1:20 or 1:30 risk of dying by avalanche over our lifetime. We need to both make good decisions *and* find ways to moderate our behavior in high consequence terrain. Tom Grant, a Chamonix-based IFMGA guide and extreme skier, reflects that it's not the gnarliest, steepest terrain that has killed the world's best steep skiers for the most part, but rather their repeated exposure to serious freeride terrain that they ride regularly.

A MENTAL TOOL FOR HIGH CONSEQUENCE TERRAIN

In her book *Thinking in Bets*, Duke argues that the decisions we make are simply bets on the future. Jenna Malone's interpretation of Duke's work (TAR 38.3) provides an insight into how we can view our interaction with avalanches by assigning each avalanche problem a different value in the form of a poker hand of cards, to address differing uncertainty and consequence of each avalanche problem type.

In an avalanche context, Duke's bet theory has the capacity to be adapted to real time and at a slope scale:

* In the five-year period to March 2006, 18% of victims were guided. The study does however, suggest that guides got better at their job. In the 1980s 38% of those dying in avalanches were guided.—The term guided included certified guides / ski instructors and trained leaders but not recreationists leading a group. Source SLF

* 14% of avalanche deaths in France over a 20-year period involved French IFMGA certified guides. Source Alain Duclos—*How to Improve the Avalanche Knowledge of Mountain Guides*

Overnight wind and an early season snowpack felt like we were holding a middling poker hand in the backcountry of Tignes despite the lack of any evidence of avalanche activity and a Moderate forecast. Perhaps a pair of 7s. Skiing the low angle/ low consequence terrain choice, we released two remote avalanches on steeper convexities. The house won. Skier: Bruce Goodlad. ■ MIKE AUSTIN

Right here, right now on this slope that I'm about to ski: How good is the hand am I holding? How likely is it a winning hand? Is it four aces...or on reflection just a pair of 9s? Do I wanna bet everything on this hand of cards?

WANNA BET? TRIGGERS US TO VET & CALIBRATE OUR BELIEFS

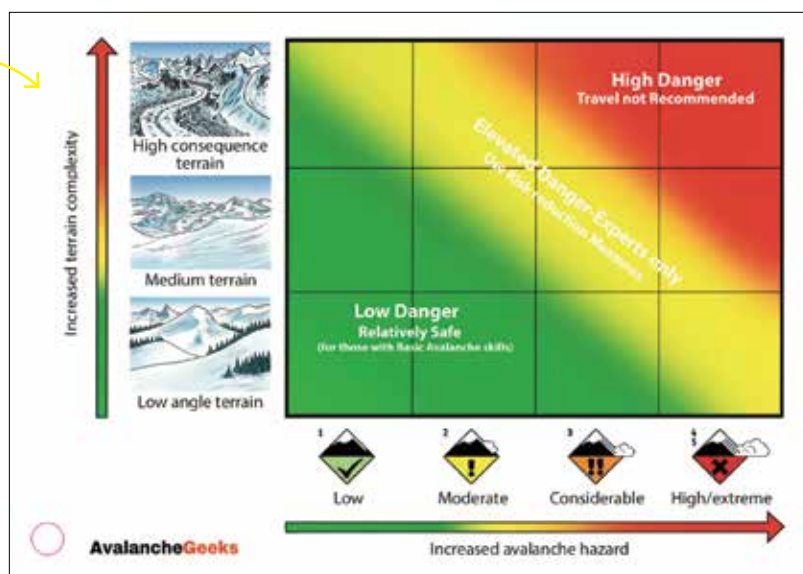
Because we are making decisions in the aggregate over many years, making small changes in our behaviors and the margins we adopt has a disproportionate effect to our outcomes over extended periods of time. Minor changes towards being more conservative add up over the years. Conversely, even being mildly more aggressive in our terrain choices will stack against us in the long run.

Asking ourselves if we 'Wanna bet?' forces us to acknowledge uncertainty and that potential loss is present in a decision we are about to take. It provokes the following questions without us necessarily being conscious that we're even asking them and forces us to question our belief in an outcome:

- **How do I know this?**
- **Am I missing something?**
- **Do I have enough information & is it up to date?**
- **What is the quality of my information?**
- **What's the consequence of getting this wrong?**

'Wanna bet?' triggers us to take an inventory of the information available to us. Its beauty is that one simple two-word question at the top of a mountain slope has the capacity to jump start our cognitive reasoning. This then would appear to be a powerful decision-making mental tool.

Whilst simplistic mental tools allow us to free up capacity, Andrea Mannberg from the *White Heat Project* at the University of Tromso warns that they are prone to abuse by the exact user group that they aim to protect. The more experienced we are, the better we are at finding reasons for what we do is the right thing. She argues that we will always try and fool ourselves to believe we are holding a Royal Flush at the top of each slope. In addition, the consequences of losing a bet when operating in avalanche terrain compared to playing poker is on a different scale. While poker players, like backcountry skiers, are always working with information deficit and uncertainty, they don't die if the decision they make don't work out! Perhaps we can tweak 'Wanna Bet?' to counteract our biases and serve our purposes better?



Ski Guide that constantly operates in green zone: risk of death over lifetime: 1:40 Regularly operates in yellow zone: risk of death over lifetime 1:20 Regularly pushes in red zone: risk of death over lifetime 1:10 (Lifetime = 100 days per season for 20 years, then 30 days per season for 20 years)



Above: Abandoning the game on the Gervasutti Couloir on the Tour Ronde. Snow conditions in the chute weren't as we'd anticipated, feeling hollow and wind hammered as we booted up. Another team was already in the couloir ahead of us. The line stopped feeling like a sure thing and we folded our hand. Skier: Sarah Thompson. ■ MIKE AUSTIN

SHORT STACK STRATEGY. HOW POKER PLAYERS OPERATE IN MUST NOT LOSE SITUATIONS.

There are strategies for when poker players cannot afford to lose a hand. It's referred to as Short Stack play. If the player only has a short stack of poker chips to play with, then they cannot afford to lose a single hand. Short Stack poker is do or die poker. Now we're talking!

The commonalities between a Short Stack poker Strategy and operating in complex, high consequence avalanche terrain are many. Now, like the ski guide, the poker player engaged in Short Stack Strategy can't afford to lose a single hand. Rules that short stack players abide by are:

Make sure your risk is worth the reward. *Only play if you have a great hand! How big is the reward... is it something special or can I get the same reward playing at a different table?*

Only play the simple hand. *Simple linear games that follow an obvious and expected pattern. The win is flagged from the outset. Wait for the obvious win—don't play anything else.*

Pre-Mortem. *How will this play out? If I'm wrong, what's the worst that can happen? What are my margins? What are my previous experiences of such a situation?*

Know when to fold and walk away from the table. *How strong is my hand? If things aren't lining up in the anticipated manner then their default position is to abandon the hand. Walk away after the big win and don't get greedy.*

Choosing not to play a weak hand is our strongest tool in complex avalanche terrain. Ultimately, we win by not losing. Our strategy should be not to win playing the game, but to not lose when playing the game (Munger & Ellis). As Mannberg suggests, the skill is recognizing that we are holding a potentially losing hand and that we should walk away.

DECISION-MAKING

So when should we bail and walk away from the table? Using situational awareness within the context of a Short Stack Strategy we can hedge our bet. We can look for early signals of trouble and use them to initiate an exit when operating in high consequence avalanche terrain. *We will exit the game when:*

We see unexpected warning signals. Not an avalanche problem that we were anticipating and have a strategy to manage, but something that has entered the day unexpectedly. When we have done our preparation diligently and something unexpected completely left of field comes onto our radar for the first time.

Notice an anomaly. Anomalies kill experts and should be viewed as a red flag. Novel and unexpected situations or events should be viewed with extreme caution. Anomalies by their nature often initially appear as minor and insignificant, as glitches in the matrix, so are easily missed. Run away. Is this the beginning of a new pattern?

When the environment changes. An unexpected deterioration of weather or unanticipated snow conditions. A zone we thought would be very quiet is busy with other skiers. That wind slab is MUCH more reactive than anticipated.

When our margins run too thin. Our margins are our aces. Count them. We lose an ace when we lose a margin of time/ equipment/ weather/ health/ skilled partner.

It's important to note that Duke advocates the complete abandonment of the game at this point and not use any of the above exit signals simply to trigger a reassessment. We know that we are subject to strong pressure biases when our goal is in reach, and that we don't act well in response to new information in these situations.

This is the unpalatable essence of the short stack strategy: Duke stresses having the courage to cut our losses as a positive thing when it comes to long term winning. The strategy is more nuanced than a go-no-go tool; it's a threshold alarm when operating in big mountain, high consequence terrain.

DELTALANCER AVALAUNCHER AMMUNITION

Designed & Developed by Delta K EES Ltd. in the UK.
Cooperatively Distributed by Avalanche Control Logistics LLC and Accurate Energetic Systems LLC in the USA.



Key Design Characteristics:

- Safe replacement of Slip-pin ammunition variants
- Turbine controlled safe arming mechanism
- Pentolite or enhanced RDX based loading options
- Low inertial loading of blasting cap to improve safety
- RECCO reflector cast into main filling
- Advanced aerodynamic profile
- Inert and powder marker loads for ranging and/or training
- Future proof design supports ongoing product optimization



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**Skiing
Complex
terrain is
high stakes
poker. We
win the
complex
terrain long
game by
not losing a
single hand
at that table.**



A 2000-foot steep run on 8 inches of fresh at the Col Du Aravis on a locked up base with a strong team. A straight flush. Skier: Mike Austin.
SARAH THOMPSON

We need to be more willing to step back from anything that isn't a clearly signaled win in complex terrain. Solid preparation and good planning will then allow us to shift our day to less dangerous terrain options. Skiing Complex terrain is high stakes poker. We win the complex terrain long game by not losing a single hand at that table. Repeated over many years, this marginal shift in our behavior pushes us further into the green zone. .

**BECAUSE THE HOUSE ALWAYS WINS
—DANNY OCEAN**

Whether imposing a Short Stack Strategy upon ourselves in high consequence terrain is enough to counter our overconfidence is debatable. But it offers a pause in which we can re-evaluate and aids us to self-calibrate when dealing with uncertainty. Due to the function of *repeated exposure* in the high consequence environment of the mountains, where information deficit and uncertainty are the norm, our default mindset should be much more conservative and our willingness to step back more recognized when operating in complex terrain. ●

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MIKE AUSTIN is the co-owner of AvalancheGeeks, an avalanche school based in the Chamonix valley providing A3 syllabus courses. An AMGA Assistant Ski Guide, he has ski guided over 25 seasons, from the US & Canada to Iceland, Norway & Antarctica.

Another Cycle of a Lifetime

BY MARK SAURER

Wednesday February 17, 2021. I finally made it home around 7PM to find TAR 39.3 waiting in the mailbox with my article about our February 6–8, 2020, storm and historic avalanche cycle. I let out a wry chuckle as I tossed the issue on the couch because I had just spent another 15-hour day mostly in my UDOT truck and once again trapped between two D4 debris piles over the road. How many once in a career, historic avalanche cycles can I expect to see in this job?

This time around, February 2021, from the 12th through the 18th we recorded 84" of snow with 6.81" of water (Alta Collins plot recorded 103"). This is the same water amount as last year's event, but with over twice the snow; low density "road snow" as Alta's Howie used to describe it (with a tone of warning in his distinctive voice). And road snow it was: we recorded 207 avalanches D2 through D4 with 33 confirmed road hits.

Much earlier that day I was again in a pre-dawn convoy up the closed and **interlodged** canyon.

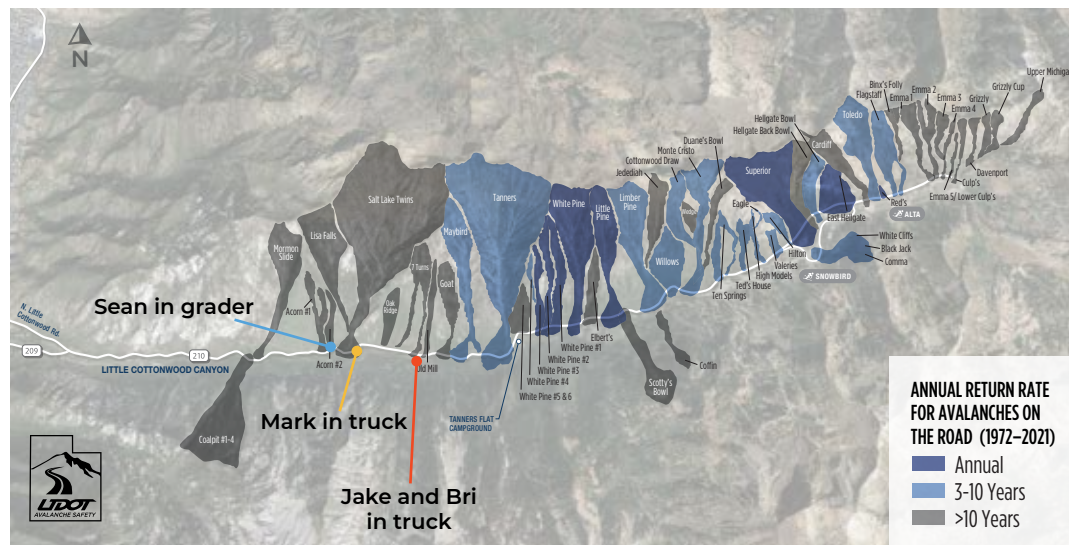
Our HST to that point was 72 inches and we'd had several rounds of control work since the storm's onset. Our 0330 uphill convoy, consisting of myself, maintenance supervisor Jake, his assistant supervisor Sean, and UDOT coms diva Bri, had no plans of venturing above the 7 Turns plow turnaround following protocols implemented after the February 2020 cycle and the several close encounters related to it (again, refer to TAR 39.3). We also communicated our movements and progress clearly to the crew up at our Alta Guard office from the moment we left the plow shed. Thanks to our infrasound detection system, we were fairly confident that several paths had run big overnight and buried the road from Tanners to Snowbird Entry 1. In fact, when the four of us drove down the previous afternoon

Tales of life up in LCC often involve reference to being "Interlodged." It seems like many of the thousands of people who have experienced an Interlodge period over the years don't really know what the law means or what it's for. It's also often incorrectly referred to as "Innerlodge" as in "we were innerlodged the whole weekend up at Alta and couldn't even ski goddammit!" The law dates back to the early days of Alta Ski Area and Monte Atwater. During times of heightened avalanche hazard and/or active control work, inter-lodge travel (ie, outside travel between the lodges of Alta) was, and still is, prohibited. This law is enacted as needed and enforced by the Alta Town Marshal often in consultation with us, the avalanche forecasters. The Snowbird Village under the authority of Snowbird Public Safety and SLC Unified Police also enacts and enforces a similar statute. The legal standing is very similar to that which many resorts use to enforce closures in their in-bounds terrain and our backcountry closures prior to active avalanche control work. Violating these closures is a class B misdemeanor.

1. Sean's view as he pushed upcanyon into the Twins debris and realized he could go no further. **2.** SEAN WRIGHT **2.** Jake's tuck entombed in the Pullout debris. **3.** MARK SAURER **3.** As the debris melted through the spring, the magnitude of tree and shrub destruction from the 7 Turns slide became evident. **4.** LAURIE DELANEY



LITTLE COTTONWOOD CANYON SLIDE PATH ZONES



after a full round of morning control work, White Pine Chute #2 crossed the road about 20 minutes behind us. There was no reason to risk our necks by pushing our way uphill in the dark through debris piles like we did in 2020. There were plenty of resources up top and we could be very useful as a lower canyon crew for the day. On that drive down the day before, we parked the UDOT snowcat and road grader at the 7 Turns “safe spot” so we could easily access them in the morning and at least start cleaning up the lower canyon. As we rallied up in pre-dawn hours to fire up the equipment, I was thoroughly enjoying the job perk of truck face shots over the hood on a closed road. At least a foot of powder snow was covering the blacktop and I found myself wishing I had my skis to make some truck-assisted road laps while waiting for the clearance to go further up-canyon.

In my professional avalanche career, I’ve always avoided using the phrases “caught off guard” or “surprised” as both somewhat imply that one doesn’t fully understand the nature of one’s local avalanche problem. I must admit that precisely at 0534 on the 17th, we were indeed caught off guard and surprised when about two miles of ridgeline from Maybird to the south face of Twin Peaks released simultaneously and covered the road at five separate runout zones. Our chosen avalanche forecasting careers, like Formula 1 racing, can be a game of millimeters and fractions of seconds; even the smallest error in judgment or just bad luck and one can end up in the wall (or blown into the creek by an R4D4 avalanche). A few minutes before this natural release I was out of my truck digging out the Bravo Gate at the Lisa Falls parking area and watching Sean in the grader push downhill into the darkness and driving snow; a game of millimeters and seconds indeed.

Both the south face of the Twins and Lisa Falls drainages meet just uphill and north of B Gate and can potentially hit the road there, “but that hasn’t happened since ‘83 and all this snow fell on bare ground,” I reassured myself as I got back in my

truck and waited to see Sean’s lights come back into view around the corner below. Prior to this storm, our snowpack on the south-facing slopes of lower Little Cottonwood Canyon was relatively non-existent. We hadn’t let ourselves get totally lulled into complacency by the lack of a pre-storm snowpack that morning. About 30 minutes earlier, as we were firing up the cat and grader in the 7 Turns pullout, Sean and I both looked upslope through the darkness and intense snow, looked at each other then turned towards Jake. “Ya know... this hasn’t hit the road since the 80s, but why don’t we move the vehicles just uphill of the turnout and have you and Bri stay in your truck for now.” A move that likely saved their lives.

Shortly after settling back into my truck everything outside the windows went white with bits of green and brown hitting the windshield. My truck started bouncing and shifting around as if in a violent windstorm. It took just a moment to realize what was happening: airblast from a very big avalanche. The bits of green and brown were shattered tree branches entrained in the powder cloud. As I was in my white hurricane, Jake, parked where we left him in the truck with Bri, yelled into his radio, “We’re in an avalanche, We’re in an avalanche! The whole uphill side of the truck is buried!” Knowing where he was parked (and to be honest, Jake’s tendency to exaggerate when excited), I figured it was just a cut-bank release that perhaps popped out sympathetic to my Twins avalanche and sluffed around his truck. “Hang on Jake, I have my own situation going on

down here.” Then I called on the radio to the crew up at the Guard, “I’m in a big powder cloud, Lisa Falls or the Twins, Jake was also hit up above 7 Turns, I’ll get to him once I can see something.” If Lisa Falls or the Twins had crossed the road, it was just down-canyon of me, as was Sean. “Shit, I haven’t heard from him,” I thought out loud. Just then he called out on the radio; he was ok but the road was indeed buried between us. He poked at the pile with the grader and determined it was too deep to get the grader through. His plan was to head down canyon and come back with a dozer once we had daylight.

Once the snow had settled and I could see into my headlights again, I started to drive up to Jake’s location, but stopped to evaluate the situation. Damian, up at the office and on the radio base set, also urged caution before I ventured uphill. Jake and Bri were alright for now and relatively safe in the partially buried truck, we just had at least two paths hit the road which haven’t done so in almost 40 years, “what else is up there and could hit us?” I had a somewhat terrifying moment at the realization I no longer trusted any inch of this highway as a “safe zone” and felt very, very vulnerable. I called my coworker Brett Korpela who was currently interlodged in his house at Alta and asked him to pull up our maps on his laptop. “I don’t know what to trust anymore Korps. Can I work my way up to Jake without getting hit by anything else?” Four paths can possibly affect the highway in the half-mile between my location and them, but thanks to Korps’ reassurance, it seemed I had a reasonable margin of safety to at least get closer. I had my answer after a couple hundred yards when I stuffed my truck into a large debris pile filled with aspen and oak brush; the 7 Turns Path had crossed the road for the first time since December ’83. I made a radio call to let the Guard crew know I was leaving my truck and crawled out on the debris pile. I snapped a quick picture for documentation and called out to Jake. There was open road just beyond the debris pile and I could see a faint glow of lights from the cat. Jake and Bri were able to crawl out the passenger window and, as there was no moving his truck, went to the snowcat. At this time we were still thinking Jake and Bri had just been hit by a road bank sluff above the 7 Turns plow turnaround. I still couldn’t see much more than their headlamps through the storm, but as Jake was describing the scene around him, we realized this was a much



A perfect imprint of a UDOT F250 after it was yanked sideways out of the debris by Sean and the dozer.

■ MARK SAURER



An across-canyon view of the 7 Turns area of the canyon showing the combined starting zone and tracks of (from left to right) 7 Turns, Old Mill, and Pullout paths. ■ LAURIE DELANEY

Delaney's storm report as she writes more eloquently than I...

When it's all said and done, when all the avalanches and events are entered and recorded to the best of our abilities, these are some of the numbers (from the storm) between the early morning hours of 2/12 to early morning 2/18:

- Guard snow/water: 84" @ 6.81" h20, Collins snow/water: 103" @ 6.82" h20
- 70 hours full road closure, Alta interlodge 67.5 hrs, 60 consecutive
- Roughly 1 mile of road between MM 6.5-11.5 covered in debris
- UDOT active mitigation; 267 explosive detonations which include 19- 5lb Heli charges, 135 howitzer rounds, 112- RAC detonations (8 obellx, 76 gazex, 27 Wyssen, and 2- 4lb hand charge air blasts)

Of the paths that produced road-crossing avalanches (in some cases multiple times), this is the list: Reds, East Hellgate, Sixty-four Chute, Hellgate Backbowl, Two Trees, Grove, Little Superior, Main Superior, Hilton, Valeries, Turamura, Ted's House, High Models, Monte Cristo, Cottonwood Ridge, Cottonwood Face, East Willows, Little Pine, White Pine, White Pine Chutes 1, 2, and 3, Tanners, Maybird, Goat, Pullout/Old Mill, 7 Turns, Salt Lake Twins. The last four have either not reached the road since '83 or have never been recorded as reaching the road.

As always, we as a crew have to try to learn from every event and try to be better. These extreme weather events and subsequent historic avy cycles are the sort of thing you really only realize is going to occur when it's occurring. The events that played out during the tail end of this storm have certainly made us more aware of certain zones. Likewise, as resource management and damage control seem to be the things that we can most manage to ensure best-case outcomes during these events, it certainly behooves us to always try to improve on how we do things. Things that have been discussed

Jake contemplating his life choices as he stands atop the Pullout Path debris cone near his buried truck. ■ MARK SAURER



As resource management and damage control seem to be the things that we can most manage to ensure best-case outcomes during these events, it certainly behooves us to always try to improve on how we do things.

post storm include UDOT plow and forecaster resources staying up canyon as well as down-cyn, trying to determine when no one should be on the road-way, including in the lower cyn, and looking at where to pull resources from during a rescue, especially in the lower cyn.

As things played out during that portion of the storm it was managed about as well as can be hoped during the circumstances, and everyone dealing with the lower canyon chaos did the right thing with the situation they were given. Everyone made it out of there ok. As one of the closest calls we as a team in LCC have experienced; however, we are certainly all committed to doing our best to never repeat it. ■



MARK SAURER had to evacuate his home outside Park City in advance of a wildfire like so many others this summer. Facing the Sophie's Choice of saving his skis or his bikes, he chose the bikes. Happily the house (and skis) are still there. He plans to return for his 9th season as a UDOT Forecaster in LCC and as a Park City Patroller for his 25th season.

larger avalanche than just a road bank. Instead, the Old Mill and Pullout paths had connected at the ridgeline 2500 feet above us and had run larger than recorded in any of our modern records. The road was buried with debris up to 15 feet deep and full of uprooted scrub oak, maple, and mountain mahogany.

Our plan was to have them drive the cat down to me then we'd evacuate the canyon and wait back in the warmth and safety of the plow shed. Except that the cat, embedded in dense wet slab-type debris and logs, was not moving either. Instead, using our radios and headlamps, I directed Jake and Bri towards me on the 7 Turns debris field. They had some difficulty climbing through the debris in the dark whiteout conditions, but eventually saw my lights and made it to me. We all jumped back into my warm truck and I backed us down the road to relative safety just above the Twins runout apron. And there we sat listening to more avalanches roar through the darkness down the north-facing couloirs across the canyon.

It was a few more hours before Sean returned in a leased dozer, accompanied by Steven Clark (forecaster and program manager) as his avy guard, to start punching a driveable hole through the Twins debris. The storm had finally begun to abate and we were confident of no more natural activity above us (was there anything left to slide?), so we began the work of liberating the grader and cat from the pullout debris. It took much digging by hand and tugging with the dozer and a massive tow strap to eventually pull both vehicles free. Both were relatively undamaged aside from some bodywork on the truck, dimpled from the trees packed around it. One of our most memorable images of the cycle is the perfect imprint Jake's Ford F250 left in the wall of the hole from which it emerged. Jake was uncharacteristically quiet as he watched the dozer work; in the morning light he was perhaps finally able to digest the scale of what had occurred and how close we all came to tragic disaster.

It's the nature of our profession to use remarkable events, near-misses, and accidents to learn and grow. As I did with last year's storm I'll pull directly from fellow forecaster Laurie

A CONFLUENCE OF Factors

bad basal facets



human Covid behavior



February storm cycle



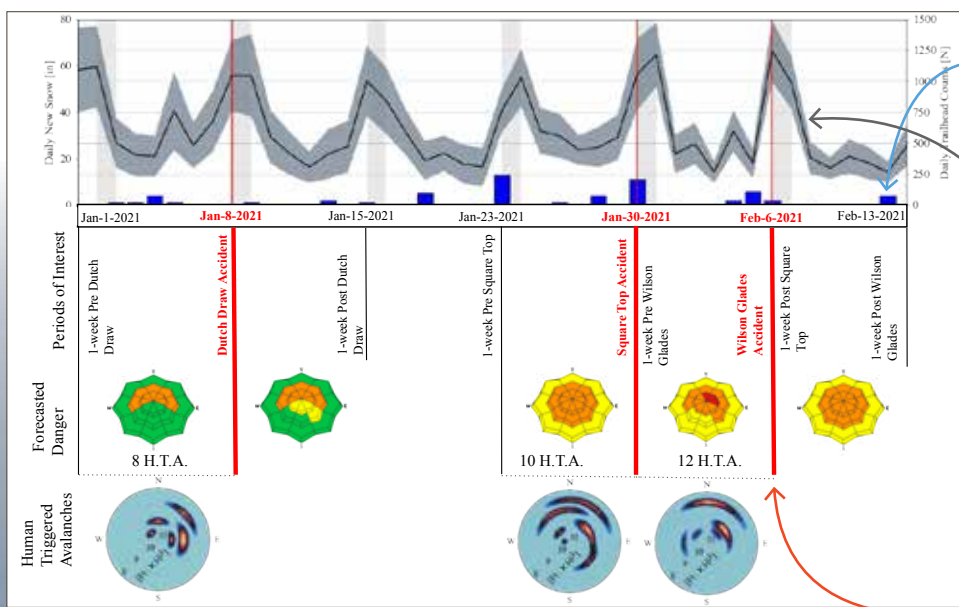
the most deadly avalanche season since 1950

QUANTIFYING ENVIRONMENTAL WARNING SIGNS AND HUMAN BEHAVIOR FOR THE DEADLY 2020–2021 AVALANCHE SEASON IN THE CENTRAL WASATCH, UTAH

BY
FRANCINE MULLEN,
TRAVIS MORRISON,
DAVID CARROLL,
PAUL DIEGEL,
AARON LONDON,
CHELSEA PHILLIPPE,
& CRAIG GORDON

The Rider Uniter Program was born at the beginning of the global Covid-19 pandemic. As ski resorts were shutting down, it seemed as if the world desperately grasped for a sense of normalcy and comfort. The Central Wasatch Mountains, located in Utah, U.S.A., much like other backcountry areas, experienced an overwhelming increase in use in the spring of 2020. This increase in usership coupled with a growing surrounding population suggested that backcountry use was not going to slow down in the coming seasons, and as a matter of fact, it was exploding!

Recognized as the hub of backcountry avalanche forecasting for the region, the Utah Avalanche Center (UAC), is an organization with a mission centered around public safety and avalanche education. The UAC, in partnership with Wasatch Backcountry Alliance and Wasatch Backcountry Rescue, began collecting numbers of users and analyzing the data to improve operations and educational programs. Using pre-existing TRAFx Trail Counters at various trailheads around the Central Wasatch, we pilot-tested additional low-cost Arduino-based data loggers which could count trailhead users. And, in conjunction with beacon checkpoints (Are You Beeping Trailhead Signs) we could then capture whether those users were wearing avalanche transceivers or not. While the additional data supplied from the data loggers is still being processed, raw numbers from the TRAFx people counters represent how many users travel into the backcountry each day. This information, combined with the complex and dangerous snowpack observed in the Central Wasatch during the 20–21 season, provides a unique opportunity to begin to examine human behavior in the time leading up to and in the wake of several separate disasters.



TIMELINE OF PERIOD OF INTEREST: JANUARY 1 TO FEBRUARY 13, 2021

Background

The 2020–21 winter season in the continental United States was one of the deadliest avalanche seasons in the last 100 years, with the western United States suffering 33 avalanche fatalities, of which Utah accounted for six (CAIC, 2021). At its height, during the week of January 30th through February 8th 2021, there were 16 total avalanche fatalities nationwide, with four of those occurring in Utah's Wasatch Mountains on February 6th. This tragic, multi-person accident was preceded by two separate avalanche fatalities just a few weeks earlier, and all less than 10 miles away from each other. From the beginning of the season, several environmental elements led to an unusually dangerous snow structure and, in conjunction with a variety of human behavioral factors, culminated into a devastating period for Utah's backcountry community. These factors include, but are not limited to, a persistent weak snow-pack, observed increased backcountry traffic, and the Covid-19 pandemic.

Numerous efforts have attempted to assess human behavior and decision-making for winter backcountry recreationists. However, a majority of these studies use a single-method, single data source approach. Examples include intercept surveys (Tremper and Ream, 1988; Gleason, et al., 2006; Silverton, McIntosh, and Kim, 2007; Fitzgerald et al., 2016), online surveys (Maartensson et al., 2013; Winkler and Tschel, 2014), stated choice experiments (Chamarro et al., 2013; Haegele and Strong-Cvetich, 2020), accident analysis (Zweifel et al. 2012; Harvey and Zweifel, 2008; McCammon, 2004), and even time-lapse photography (Saly et al., 2018). Studies employing multiple methods or mixed-method techniques offer significant advantages for bias reduction and data integration (Patton, 1999; Carter et al., 2014; Thierbach et al., 2020), despite the advantages these approaches bring, they are mostly absent in the avalanche community (Alain et al., 2008; Johnson and Hendrikx, 2021; Hendrikx et al., 2021; McCammon et al., 2008).

Nonetheless, complex interactions and feedback between all aforementioned variables are rarely studied in the context of one another and may provide insight to understanding backcountry usership (where, when, and why people recreate). This research project, which integrates multiple data sources, data modalities, and methods, offers the opportunity to use powerful data mining tools to develop important insights not

Although Cooke City, Montana had fewer avalanches break on facets near the ground compared to the rest of the area, on January 8, three skiers from a group of six triggered and were caught in a large avalanche on The Fin. Two were injured with one requiring helicopter evacuation. This early incident foreshadowed the particularly bad month to come. See the Gallatin National Forest Avalanche Center summary on page 46.

■ BEN HOINESS

The top figure presents the daily new snow accumulation (blue bars) in inches.

The black line represents the total daily trailhead count for both Big and Little Cottonwood Canyons while the shading above the line represents the spatial range.

Beneath the time series plot, one-week mean forecasted danger roses for the Central Wasatch mountain are presented for the time about each fatality (red vertical lines).

Green represents low, yellow is moderate, and orange is considerable danger.

Heatmaps of the elevation and aspect of user-triggered avalanches are presented for the one-week period prior to each fatality event.

previously possible (Pastrana et al., 2019; Lee, 2020; Giudici and Figini, 2009). To accomplish this, we combed through trailhead time series data, pored over reported avalanches along with forecasted avalanche danger issued by the UAC, and examined the links between these variables around the weeks surrounding avalanche accidents.

PURPOSE

Throughout the course of the winter, UAC forecasters and educators are often asked, "So, how many people do you think are in Utah's backcountry on any given day?" Of course, it's easy to fall back on our broad-brush answers, "Just look around, this place is getting loved to death." However, quite frankly, we really don't know.

The initial purpose of this project was to define a quantitative number of how many people are actually streaming into the backcountry on a daily basis. But, like most exploratory studies that require an army's-worth of personal skin-in-the-game, we immediately realized the best bang for the buck was building on the large datasets already available in the Wasatch. A couple of espressos deep into the planning, popular Wasatch trailheads were identified as representative trailheads for traffic history to allow us to analyze trends and traffic density. Coupling the trailhead usership data with observations submitted to the UAC and historical weather data from the canyons, the opportunity to begin developing informative models, extracting insights, and putting hard values to long-time assumptions became a reality.

Using these datasets, we embark on an open-ended exploratory research project which may help understand and quantify research questions such as:

- How long do people wait after a storm to go into the backcountry?
- Is user traffic rising before the natural avalanche cycle is over after a storm?
- What is a user's likelihood of triggering an avalanche or avoiding avalanche terrain altogether, based on years of



If people want to ski, they will ski.

Avalanche crown in Wilson Glades, Utah from a fatal avalanche that killed four people on February 6th.

BRUCE TREMPER

triggered avalanches (HTA) one-week prior to each accident are presented to demonstrate the aspect and elevation of relevant activity. Eight to twelve HTAs preceded each fatality event with a majority of activity occurring on high elevation, northerly aspects, corresponding to our persistent faceted weak layer. From this analysis, we cannot comment on where users are recreating when entering the backcountry with our data, however, we do assume that the likelihood of users recreating on what was a dangerous northerly aspect increases as more users enter the backcountry. This is

experience, recent red-flags, and forecasted hazard?

- How well do users grasp what we are trying to convey in our forecast and messaging?

Armed with this insight, we plan to utilize these findings to implement appropriate wording in both public and media specific messaging, avalanche education, and avalanche forecasts.

Methods

The study period focuses around three separate fatal avalanche accidents that occurred in the 2020-2021 season in the Central Wasatch Mountains, Utah. Two single fatality events occurred on January 8th, 2021 (Dutch Draw, Park City, UT) and January 30th, 2021 (Square Top, Park City, UT). These events were followed by a multi-fatality accident (six buried, four fatalities) on February 6th, 2021 (Wilson Glades, Millcreek, UT). Snowpack conditions prior to and during these accidents revealed an unusually thin, yet complex snow structure. This deceptively tricky snowpack led to dangerous avalanche conditions, especially on upper elevation north-facing aspects, with a layer of faceted snow near the ground. Trailhead usership, weather data, avalanche observations, and avalanche forecasts datasets were combined to examine the time period leading up to and after the accidents.

For this study, TRAFx trailhead counting systems, which use an infrared beam path across a trail of interest (range of 6 m) recorded beam breaks hourly (TRAFx, 2021). Here, it is assumed that every two beam breaks across the defined area of study corresponds to one trailhead user, which likely underestimates usership (one break for outgoing, one break for incoming traffic). The systems were placed at 12 representative trailheads in Little and Big Cottonwood Canyons outside of Salt Lake City, UT. Additionally, field observations from backcountry users and avalanche professionals were used to identify human triggered avalanches for aspect and elevation (Utah Avalanche Center, 2021). For this study, we only present human-triggered avalanches (HTA) which were reported in the Central Wasatch. Daily new snow totals were captured from the MESOWest network reflecting

the mid-mountain Snowbird snow stake, located in upper Little Cottonwood Canyon (Synoptic Data Corporation, 2021).

Results and Discussion:

Figure 1 presents a timeline of the trailhead, weather, observation, and forecast data from January 1, 2021, to February 13, 2021. The top timeline plot (black line) shows the daily total trailhead count for all 12 trailheads in Little and Big Cottonwood Canyons, with the light-gray vertical shading in the background representing weekends. The shading around the line presents the spatial traffic range (maximum minus minimum for a single day) across all trailheads, meaning when the shading is large, usership is confined to a smaller number of trailheads (likely upper elevations where coverage and riding conditions were better). Trailhead use remained high, even in the light of fatal avalanche accidents (red vertical lines). Observations show even peak usership, 1230 trailhead daily counts, occurring the day after the Square-top accident (January 31, 2021). Beneath this black line, blue bars indicate the daily amount of new snow. In the following days after new snow accumulation, an increase in usership is observed in all cases. Another influential variable on trailhead use was the day of week, as weekends observed large usership, and weekdays generally saw lower usership. Combining these factors shows a general pattern for usership. For example, new snow accumulated in the days leading up to and on the Square-top accident, which, when coupled with this weekend day, a Saturday, likely resulted in the peak observed usership over the period. This suggests that backcountry usership may be more tightly related to the day of week and riding conditions, versus news of tragedy occurring just miles away.

Beneath the timeline, one-week temporal averaged forecasted danger roses present the forecasted danger based on aspect and elevation. During the period of study, a gradual increase in forecasted avalanche hazard spread from zones only encasing high elevation northerly aspects to other aspects and lower elevation bands. Beneath the forecasted danger rose, heatmaps of human

supported by the peak level of usership observed with low spatial range (a lot users observed at all trailheads which access a wide range of terrain) during periods of considerable and high danger and in light of recent red flags, such as recent avalanches and accidents. In other words, it should be assumed that recreationists will use the backcountry at their discretion, despite relevant warning signs on certain aspects and elevations (**if people want to ski, they will ski**). **If this assumption is correct and if users recreate on dangerous slopes even in light of sobering events, there may be a potential discontinuity in how, when, and where users are recreating in the backcountry and what forecasters anticipate users will do.**

Conclusions & Future Work

Like all data geeks, we wanted to compile and crunch data and create cool-looking graphs, but the heart of this project lies in saving lives. We still have a lot of unanswered questions, but at the end of the day we began to quantify traffic density, especially during times of increased avalanche hazard or unstable and dangerous snowpack conditions. Future work includes determining which number of recorded users are carrying avalanche transceivers, adding user surveys to understand danger rating interpretation, and classifying avalanches observed on the D-scale. We also intend to look back and hindcast to see if our current messaging resonated with users and if they understood the consequences associated with the avalanche danger rating and the severity of the avalanche problem.

In addition to the work presented here, in a preliminary survey of recreationists, results collected by Paul Diegel in the Central Wasatch provide significant (n = 939) insight into users' understanding of the Utah avalanche forecast for a particular day. Initial findings suggest that users are likely to understand avalanche hazard level, but fail to name the avalanche problem type (e.g., weak layer, wind loading, etc.) forecasted for that particular day and region. We intend on refining the survey and analysis of the results to understand user forecast interpretation with the presented datasets.

Let's face it, avalanche forecasters and educators alike generally assume that when the avalanche hazard is HIGH or in the aftermath of a high profile avalanche accident, backcountry travelers tone it down. We even assume that some winter recreationists may even avoid the backcountry altogether. Indeed, we've been talking about this forever and crafting our messages to fit this preconceived notion. But, for far too long we've been speaking a complex syntax of avalanche hazard, snow structure, and snow crystal type. We shake our heads when we see backcountry users making questionable decisions or if they're confused by our messaging. What don't they get? But maybe we're part of the problem. Perhaps we're giving the public a Miles Davis infused free-form jazz when what they really want is simple rock n' roll. In essence, if we are constructing a complex messaging lock, how can we expect the public to create a key to open it up? Indeed there's a lot we still *don't* know!

Call to action

We *do* know that all avalanche accidents are devastating to everyone involved, and we didn't want this season's tragedies to become just a statistic cited in avalanche classes or case studies. Our intention is to utilize these findings to retool our messaging when applicable, especially during times of heightened or complex avalanche danger. After analyzing this year's trends, we intend to not only anticipate where periods of elevated avalanche danger and increased backcountry traffic intersect, but to also move quickly to develop effective time sensitive messaging to help prevent even more tragic avalanche accidents in the future. This year's plan is to take these findings and implement appropriate wording in both public and media specific messaging, avalanche education, and avalanche forecasts. 🟩

Acknowledgments

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FRANCINE MULLEN is the Program Coordinator at the Utah Avalanche Center, where her efforts are focused on avalanche education, awareness programs, and trailhead research.



TRAVIS MORRISON, Ph.D. is a Postdoctoral Researcher at the University of Utah, in the Dept. of Mechanical Engineering, where he focuses on fundamental weather research, instrument development, and snowpack and avalanche forecasting.



DAVID CARROLL has been an avid backcountry skier for the last forty-seven years. For the past six years he has been a board member of the Wasatch Backcountry Alliance where he's been extensively involved in running the trailhead monitoring program.



AARON LONDON has been touring in the Wasatch for over a decade. In 2019 Aaron joined the Wasatch Backcountry Alliance board where he has helped lead the trail counting project, which is vital to helping our community understand when, where, and just how many of us are out there in the backcountry.



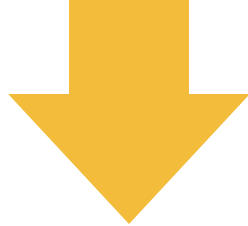
CHELSEA PHILLIPPE is the Trails Inventory and Planning Specialist for the Salt Lake Ranger District on the Uinta-Wasatch-Cache National Forest. Her Graduate thesis work in Resource Conservation focused on human dimensions and recreation.



CRAIG GORDON has over 30 years of on-the-snow avalanche experience and is the main media contact for the UAC. In addition to his forecast duties, Craig regularly teaches dozens of avalanche awareness classes and created the Know Before You Go (KBYG) avalanche awareness program.



An avalanche on Mt. Trelease in Colorado that occurred February 14, 2021. The red circle indicates where the avalanche buried the victim.



SNOWMOBILE AVALANCHE FATALITIES

How the snowmobile industry cut average annual US motorized avalanche fatalities in half

BY MIKE DUFFY

HISTORY

The late 1990s and early 2000s saw a drastically increasing number of North American snowmobile avalanche fatalities. Snowmobilers became the user group with the most fatalities year after year. The numbers were staggering and increasing. It was a burden on rescuers and the sport was receiving significant negative publicity. At the time, avalanche courses were skier-focused, taught by skiers with information from a skier's perspective. Want to take level 1? Better learn to ski first. There were very few avalanche instructors that offered motorized specific classes, even though snowmobiles have been manufactured since the late 1950s.

I'm an avalanche educator for skiers and motorized users. I had to take all my avalanche classes on skis. The light bulb moment was skinning in class for hours to get above timberline. I was thinking, I could have been up this on my sled in 10 minutes, but instead I'm skinning for hours. This is exactly why motorized users are not taking on-snow classes. I saw the need for motorized-specific classes by someone who understood the sport.

In 1996 I taught my first motorized on-snow avalanche class. Avalanche1 was started in 2006, which specialized in motorized avalanche education and went nationwide. I realized right away that snowmobilers will take classes when they are welcome, the techniques relate to their sport, and the instructor participates in, understands, and supports their sport. Goal of Avalanche1 was to reduce snowmobile avalanche accidents and fatalities with effective, proven, and affordable education from a snowmobiler's perspective. As much as I taught, it didn't seem to be making enough of a difference, as accidents and fatalities were still increasing. We had a long way to go.

US Avalanche Fatalities: SKIERS VS. SNOWMOBILERS 2007-2010

YEAR	TOTAL	SKI	SNOMO	SNOMO % OF TOTAL	RANK
06-07	20	9	10	50%	#1
07-08	36	9	13	36%	#1
08-09	27	4	16	59%	#1
09-10	36	9	17	47%	#1

In June 2010 I was asked to speak at the International Snowmobile Congress in Iowa. The 2010 speech I gave in Iowa wasn't sugar coated. I bluntly stated that the large number of motorized avalanche accidents were inexcusable, very preventable, and changes needed to be made. I presented techniques that, if implemented, would make a difference in reducing accidents. After the presentation, Bombardier Recreational Products (BRP) stated they were going to do something about the problem. I had not had any support from the snowmobile industry up to this point and wondered whether it would happen. It did happen and they went all out on educating as many riders as they could for free. Long story short: the entire industry got involved and we made significant progress.

THE MINDSET ON REDUCING ACCIDENTS

To effect change in a short period of time, the industry needed to educate a large number of people. This was not going to be accomplished with level 1 classes due to the limited number of motorized instructors/courses and the limited capacity of these programs. In a perfect world, every rider would take a level 1 course as their first class. Many people were not willing to make that commitment.

Most of the motorized avalanche fatalities were due to basic mistakes. These problems could be addressed in a classroom setting.

The plan was to introduce riders to snowmobile specific training, taught by snowmobilers and encourage all students to attend on snow courses.

Bring the classroom sessions to the student's location. Make it easy to attend, affordable and effective.

The Results: The improving machines, riding techniques, and popularity of mountain riding would lead most to think reducing fatalities significantly would not be possible. The machines from 2010 were not as capable to access the terrain we are now accessing throughout the entire winter. As the popularity and exposure increased, could the fatalities decrease? Average annual U.S. snowmobile avalanche fatalities have been cut in half since winter 2009-10.

THE PROGRAMS

Here are some of the programs that made a difference:

- Ski-Doo offers free avalanche education classes.
- Avalanche Awareness classes. Very successful in getting riders to attend on the snow courses. Growth of level I motorized class participation has grown every year.
- KYBG. Know Before You Go.
- Throttle Decisions.
- Backcountry Zero.
- Backcountry Ascender. Free online motorized avalanche education. Supported by the International Snowmobile Manufacturers Association.
- Avalanche Forecast Center education programs.
- Other motorized course providers and locations: AAI, AIARE, Alaska Avalanche School, Avalanche1, Backcountry Institute, Silverton Avalanche School, Six Points Avalanche Education

US Avalanche Fatalities: SKIERS VS. SNOWMOBILERS 2011-2021

YEAR	TOTAL	SKI	SNOMO	SNOMO % OF TOTAL	RANK
10-11	25	8	4	16%	
11-12	34	14	9	26%	
12-13	24	8	1	4%	
13-14	35	10	11	31%	#1
14-15	11	6	2	18%	
15-16	30	11	10	33%	
16-17	11	6	3	27%	
17-18	25	9	11	44%	#1
18-19	25	14	8	32%	
19-20	23	8	8	35%	#1 tie
20-21	36	18	10	27%	

OTHER AREAS WHERE PROGRESS HAS BEEN MADE

- Avalanche Forecast Centers increased use of snowmobiles.
- More motorized papers at ISSW.
- Motorized rescue techniques being adopted.
- Motorized professionals having more of a voice in A3.
- Higher Standards for Motorized instructors and collaboration of techniques.

HOW DO WE KEEP THE BALL ROLLING IN THE RIGHT DIRECTION?

Some suggestions:

- Introduce avalanche information in more youth snowmobile programs.
- Educate consumers at point of purchase.

- Mentorship programs with clubs/associations. Certain level of training required to attend organized rides.
- Avalanche training is a prerequisite for sponsorship.
- Mindset of being accountable for others and working as a team.
- Encourage training beyond level I.
- More avalanche forecasting for areas popular with motorized users. Some popular motorized use areas lack daily avalanche forecasts. Other very popular motorized areas do not have avalanche forecasting.

- Island Park, ID
- Big Horn Mountains, WY
- Snowy Range, WY

Solution: Motorized specific fund raising for these areas to provide forecasting. Crowd sourcing information. Bob Comey, director of Bridger Teton Avalanche Center has created a crowd sourcing site for avalanche information for the Snowy Range, WY. This format could be adopted to other areas.

Should we have a separate forecast for motorized users? A snowmobile can put up to five times more stress on the snowpack than a skier, should a separate forecast or danger rating reflect that? In many zones the forecasting is biased towards historical skier use. Many forecasters are not traveling to the popular motorized areas to check conditions. Are the forecasts biased towards skiers?

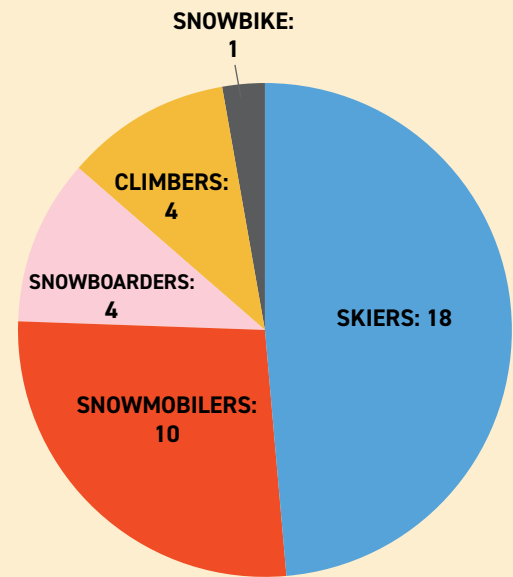
Solution: Train more forecasters to be proficient with snowmobiles and familiarize them with motorized areas. More emphasis on motorized areas, encourage public motorized observations.

Reinstate and recognize A3's Introduction to Avalanches field session course. Prerequisite is a 3-hour awareness class. This class works well with motorized demographics, especially the large number of riders from out of state traveling to the western U.S. who don't want to allot three days of their vacation to a level I class. One day of on-snow training provides some valuable skills and insight. Is also a great refresher.

FOOD FOR THOUGHT

Can the type of programs that worked for snowmobilers be adopted/successful for other user groups to reduce accidents? ●

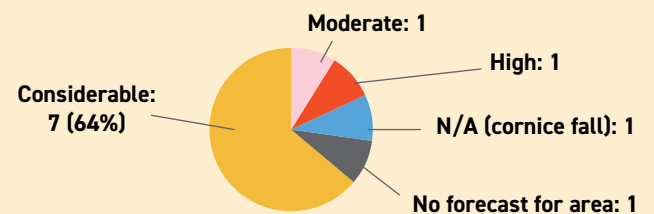
US AVALANCHE FATALITIES 2020-2021



TOTAL US AVALANCHE FATALITIES: 37
Motorized accidents (snowmobile + snowbike) = 30%

11 MOTORIZED AVALANCHE ACCIDENTS RESULTED IN 11 FATALITIES:

AVALANCHE DANGER RATING AT TIME OF ACCIDENT:



TYPE OF AVALANCHE PROBLEM: Persistent slab (91%)

BY STATE: CA: 1, CO: 2, ID: 3, MT: 1, NV: 1, WA: 1, WY: 2

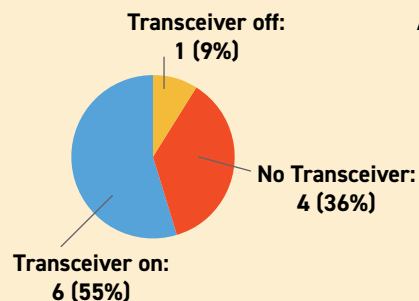
ACCIDENTS WITH RIDERS FROM OUT OF STATE: 3 (27%)

AVERAGE AGE OF VICTIM: (all male) 45.8

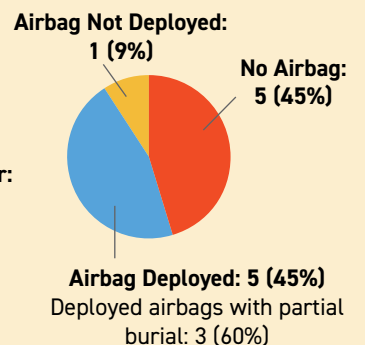
ACCIDENTS WITH "VERY EXPERIENCED" RIDERS: 6 (55%)

ACCIDENTS WITH MULTIPLE RIDERS CAUGHT: 5 (45%)

TRANSCIVER USE:



AIRBAG USE:



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Will Mook



MIKE DUFFY is Director and Lead Instructor at Avalanche1. He travels annually across the country presenting sled-specific avalanche safety training at snowmobile dealer and club locations.

This past winter was unlike any other. U.S. Avalanche Centers faced an ongoing pandemic, leading to challenges keeping employees healthy, difficulties in providing safe avalanche education opportunities, and explosive increases in backcountry use. Compounding the already complex situation, this past season also boasted prolonged instability due to the widespread formation of depth hoar and near-surface facets which created an extremely unstable foundation for subsequent snowfall across most of the western U.S.

Much of that additional snowfall came during February, resulting in widespread instabilities and a historic spike in avalanche fatalities. The 26 avalanche fatalities tallied in February of 2021 made it the deadliest month for U.S. avalanche fatalities in almost a century, with 14 fatalities occurring in the first week of the month alone. By the end of our winter, avalanches had killed a modern-day record of 37 people.

The avalanche season was also marked by an extraordinary increase in backcountry use. Though we lack solid data for the numbers of people in the backcountry, several proxy measures suggest the magnitude of the increased use. Sales of backcountry skis rose more than 140%, unique visitors to Avalanche Center websites increased anywhere from around 25% up to nearly 100%, and anecdotal observations of packed trailheads, crowded skin tracks, and tracked-up backcountry slopes hint at the increase. Our best guess is that backcountry use over the past two seasons is up anywhere from 25 to 100%.

Despite increased use, unstable snowpacks, and the pandemic, the

network of Avalanche Centers continued to provide top notch avalanche information and education. In many cases, this work required creatively re-tooling operational plans and education events to meet Covid guidance. Despite the record number of fatalities, increasing backcountry use means our *avalanche fatality rate* may have actually dropped.

Each of this season's 37 avalanche fatalities is tragic. Our hearts go out to the families and friends of the victims, and to the first responders involved in these accidents. Despite the deaths, we are proud of the accomplishments of the Avalanche Centers and we believe things would have been much worse without the great effort put forth by the entire U.S. avalanche community. With that, the season summaries section of this issue of *The Avalanche Review* will kick off with a nice article published on Powdercloud.com, and then we hope you will enjoy digging into last year's events at your favorite Avalanche Center.

—Karl Birkeland and
Simon Trautman
USDA Forest Service
National Avalanche Center

Despite the record number of fatalities, increasing backcountry use means our avalanche fatality rate may have actually dropped.

This story first appeared in the online magazine The Powder Cloud thepowdercloud.com. Thanks to editors Paul Rogers and Kimberly Beekman for permission to reprint.

BY KIMBERLY BEEKMAN

UNSPASH

In the fall of 2020, with the pandemic in full swing, the backcountry ski community was nervous. Touring gear was sold out, avalanche courses were full, and a flood of newbies—instigated by resort reservations policies and uncertainty about safety protocols—were threatening to clog trailheads and parking lots in popular backcountry zones. Worse, experienced backcountry travelers feared that the glut of inexperienced skiers and riders would result in more avalanche fatalities.

What actually happened last year is complicated. The U.S. has had the worst year ever in terms of number of deaths with 37 avalanche fatalities thus far, surpassing a dismal record of 36 in both the 2008 and 2010 seasons. Yet experts all agree there were more people than ever using the backcountry, which means the death rate actually went down from average. Furthermore, the people who died were not, for the most part, the newbies. So did the pandemic have any impact, and if so, how?

First, let's look at who the victims were. Most of the people who were caught and killed were experienced, with a median age of 44—10 years older than the average median from 1990 to 2018, said Karl Birkeland, director of the U.S. Forest Service National Avalanche Center. "In general, we had a lot of experienced people that comprised many of the victims," Birkeland said. "These weren't 20-year-olds."

In normal years, it's not unusual for experienced people to get caught and killed due to the simple unforgiving game of numbers: The more you go, the higher your risk. This past year, though, the situation more convoluted. While there aren't many solid numbers out there from trailhead use, experts across the Mountain West would estimate that backcountry use increased anywhere from 50% to 100% due to the pandemic. "We saw this huge influx, and the question is how did the influx tie into fatalities?" Birkeland said. Did the crowds push experienced people to venture into riskier terrain? Or did the stress of cabin fever push people out on days that they should have stayed home?

According to Ethan Greene, director of the Colorado Avalanche



FATALITIES, COVID, AND BACKCOUNTRY SKIING

The real story behind a historic season

Information Center (CAIC), those questions are impossible to answer without addressing the biggest elephant in the room: Last season saw an extraordinarily dangerous snowpack due to a thin early-season snowpack followed by a dry period and then large amounts of snow. “In order to get human accidents in avalanches, you need two things: people and potential for avalanches. This year was a really bad confluence of both.”

According to Greene, this season’s snowpack was a one-in-10-year event, and February was particularly fatal. This means an experienced skier who has traveled in the backcountry for 20 years would have only experienced two months that had conditions like February 2021. “The characters of these avalanches were dangerous for people. They were easy to trigger remotely from low-angle terrain, and they propagated a long way.” He compared this past season’s slides to the massive D4 and D5 avalanches of March 2019 that didn’t cause many fatalities. This past season, by contrast, saw slides that were D1, D2, and some D3. “They weren’t the landscape-altering avalanches we saw in March of 2019, but when you’re looking at the danger to people, they were much more dangerous.”

And that wasn’t just in Colorado—the weak layer was similar in Montana, Utah, Wyoming, and Idaho. “We had 25 straight days of considerable or high danger,” said Scott Savage, director of the Sawtooth Avalanche Center in Ketchum, Idaho. “We were all afraid to go into avalanche terrain because the weak layers were so predictably unpredictable. We were terrified until March. I’m sure that’s probably double the number of consecutive days of considerable or high that we’ve ever had in the past.”

As for how the pandemic played into the fatalities, it’s difficult to say exactly, but Greene feels strongly there was some connection. “Covid affected all of us in ways that we don’t completely understand,” he said. Greene feels that perhaps it was the underlying stress that could have negatively affected decision-making, especially in those who were more experienced. “A lot of us use the mountains as our escape from the pressures of the rest of our lives.

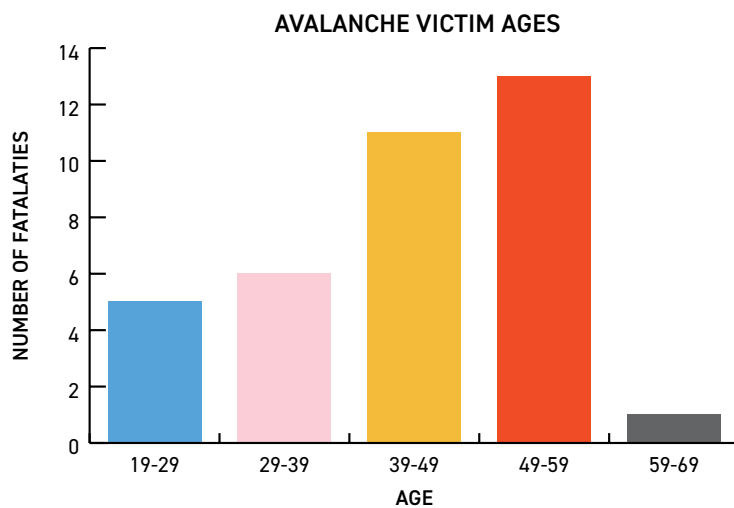
Covid put a lot of stress on us, and there’s no reason to think we could not bring that with us when we headed into the backcountry. There could have been ramifications of people making decisions in a stressful environment.”

However, along with the influx of people, the higher pandemic stress levels, the dangerous conditions, and the high number of deaths, avalanche awareness increased dramatically. The Gallatin National Forest Avalanche Center’s videos got 1.2 million views—double from the previous year. The Utah Avalanche Center had to build a new website to meet the increased demand for their products. The CAIC sent special forecast alerts and advertised the danger on TV ads and billboards and other mainstream media. In Idaho, attendance in avalanche awareness classes went up tenfold. “Each fatality is tragic. We don’t even want to have one death, but the fact that we had 36 in spite of the increased use means the fatality rate has gone down dramatically,” Birke-land said. “I think that is a story that sometimes gets missed.”

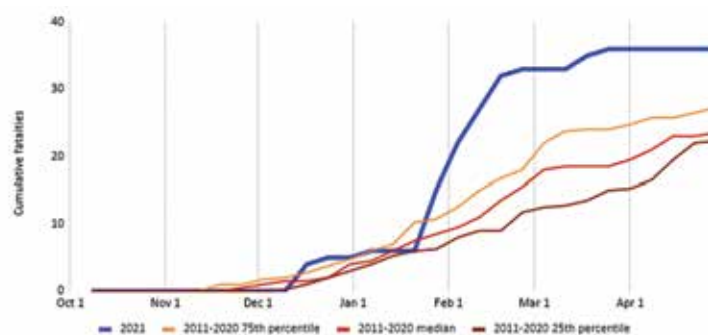
Greene agreed: “Looking back at this year, with lots of new people in the backcountry and very complicated avalanche conditions, I think that the work that the avalanche education industry did was hugely important,” Greene said. “As a whole, we did prevent a lot of accidents. Given what we saw, without that combined effort, I think things could have been much, much worse. There is a little bit for all of us to learn from and be proud of.”

Looking to the future, Greene will use the learnings from this season to continue to reach more people. It’s isn’t only classes or equipment or forecasts alone that can make a huge impact, but community involvement. “Education alone is not going to solve these problems—and forecasts are not going to keep people out of avalanches,” Greene said. “It really takes everyone together to share information. It manifests in ways it’s impossible to list.” He paused. “It’s really powerful.”

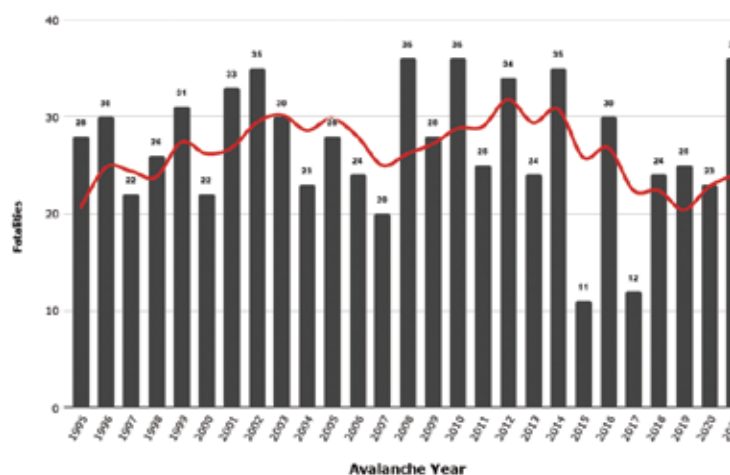
Powder Cloud and The Avalanche Review extend our deepest condolences to those who have lost loved ones in avalanches this past season. ●



2021 US AVALANCHE FATALITIES COMPARED TO PREVIOUS 10 YEARS



2021 US AVALANCHE FATALITIES BY YEAR 1994-95 TO 2019-20



Top graph data courtesy of USDA Forest Service National Avalanche Center. Bottom two graphs courtesy of the Colorado Avalanche Information Center.



KIMBERLY BEEKMAN is the former editor-in-chief of the late *Skiing Magazine*. She now works as the contributing editor of *Powder Cloud*, an avalanche education website, and uses freelancing as a beard to ski powder wherever it falls. She lives in Denver with her wonderful daughter and terrible cat.

AAIC

Valdez Avalanche Center

The 20–21 season saw average snowfall on Thompson Pass with 500” of snow recorded and 48.3” of SWE; Thompson Pass average

Snowboard triggered hard slab avalanche on April 3, Mt. Billy Mitchell, N aspect 3700', HS-ARu-R2-D2.5.



snowfall since the winter of 52–53 is 503”. Valdez itself saw a below average amount of snowfall with 240” of snow recorded with 26.4” of SWE; Valdez average snowfall is 300” since the winter of 71–72. In Valdez, a good number of storms turned to rain at sea level but stayed as snow on Thompson Pass. This season, 10 avalanches both natural and artillery-triggered affected a combined 840’ of the Richardson Highway over the course of seven days.

The Valdez Avalanche Center produced 99 public avalanche forecasts through the winter season. Although public outreach was limited by Covid, we were able to work with our local schools, utilities crews, and snowmachine club.

Our winter began in November as cold, dry, and windy. Snowfall began in earnest on November 26th with a week-long snowfall event that deposited 90” of snow on Thompson Pass with 11” of SWE. The tail end of this storm saw freezing line rising to 3000’ and 3.7” of SWE in a 48-hour period, which triggered a significant avalanche cycle with

multiple avalanches running to the ground. Fairly regular snowfall continued through December totaling 135” on Thompson Pass. This allowed for our snowpack to slowly gain strength and depth.

The first few days of 2021 brought our first clear and cold weather pattern with a winter snowpack in place. Temperatures plummeted to -30° F in valley locations on the north side of the pass causing significant surface hoar growth up to 4000’. Incremental loading occurred over the next two weeks until a series of storms between 1/15–1/21 delivered 63 inches of snow, prompting a widespread natural avalanche cycle that was concentrated in the mid-elevation band, 2000–4000’. After this storm a pattern shift brought in below average temperatures with very little precipitation and fairly frequent moderate to strong outflow wind events. Between 1/22 and 2/17 Thompson Pass received less than 1” of SWE, this combination caused significant faceting to occur in our snowpack. Surface hoar growth was limited

during this time period due to occasional strong winds.

After 2/17 human triggered avalanches became more frequent as small storms slowly added stress to a weak snowpack, coupled with our yearly usual increase of users each spring. Human triggered avalanches started out small and shallow and became deeper and wider as incremental snowfall built slab depth. By the end of March small storms had stacked up enough new snow that crown depths were a meter or more in places, mostly in our continental zone although human triggered avalanches were being reported all the way to the coast. Several near miss human triggered deep slab avalanches occurred with one resulting in multiple partial burials.

At this point something interesting happened. On 4/8–4/9 a major outflow wind event produced north winds of 95 mph on Thompson Pass, producing multiple large avalanches with wide propagations on SE-NW aspects with south aspects seeing most of the action. In the wake of this hurricane, very hard snow surfaces seemed to bridge over a very fragile snowpack. A few days later, a dramatic pattern change occurred as a Pacific storm delivered 3” of SWE over four days. Directly following the storm skies cleared and tem-

peratures rocketed into the 50s up to 6000’ with overnight temperatures staying above freezing at elevation. After two days of this weather, heat penetrated through the hard wind board, causing a significant cycle of wet loose and wet slab avalanches on solar aspects with many D3s, although large avalanches were noted on every aspect. In the matter of a week low temperatures went from -10 F to 35 above at Thompson Pass and winter turned off like a light switch. The initial spring shed removed significant weight from the snowpack and avalanche activity slowed considerably despite continued temperatures above normal and nights staying above freezing. The snowpack began to melt in place as recently as mid May, with no other significant avalanche activity noted.

—Gareth Brown

Haines Avalanche Center

Snowpack-wise, Haines had a banner year.

- 227” of snow in town (127% of normal)
- 343” at Customs (157% of normal)
- We measured peak SWE of 93” at treeline in our maritime zone
- 40” of peak SWE at treeline in our transitional zone

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With deep snowpack down to sea level for most of the winter, skiers and riders had no need to drive to Chilkat Pass to access the snow (which is a blessing, since the Canadian border is closed to recreational traffic). In fact, since the pass is not accessible for us in these lingering Covid times, HAC could not produce a reliable forecast for that zone. We focused instead on our two closer zones, and those forecasts benefited from the extra attention. Due to reduced funding, we once again were limited to forecasting for week-ends only.

The big story this winter was the unprecedented atmospheric river event of Dec 1st-7th, 2020. This ended up being a 500-year event for Haines. It caused widespread flooding, erosion, debris flows, and landslides. The largest of the landslides destroyed part of the Beach Road neighborhood, sweeping multiple homes into the sea. Two local residents lost their lives, and many were affected by losing access to their homes. This disaster stopped almost everything in the community for weeks. HAC staff spent all of December helping in the disaster response and directly participating with the Borough's Emergency Operations Center. Rainfall totals for the event were staggering:

- 24-hour total: 7.18"
- 48-hour total: 10.49"
- 7-day total: 14.85"

This atmospheric river was well-forecasted in advance. We bumped the avalanche danger to Extreme for Dec. 1 and 2. Our wording in the forecast was simple:

"If we receive as much precip. as expected, that would likely be a 75-100 year storm, as per the National Weather Service. It is not out of the question to see 75-100 year avalanches as well." We ended up with a 500-year storm. While the big story ended up being the landslides and devastation, this was also a large snow avalanche event. One avalanche at Chilkat Lake was large enough to break through the thick lake ice, causing a small tsunami that propagated across the lake and broke up all the ice, flooding the opposite shore.

It was a wild, tragic December and we were happy to get back to normal winter operations by late January. The rest of the season brought ample snowfall and relatively benign conditions, with the occasional crust-facet PWL problem but no serious accidents. We were able to teach an A3 Rescue course, Level 1 Rec, and Sled Awareness course, plus numerous other awareness courses in the community and schools.

—Erik Stevens, Jeffrey Moskowitz, and Tim Thomas.

Cordova Avalanche Center

The snowpack grew slowly in the early winter, with warm temperatures bringing a mix of rain and snow. Accumulation accelerated December and January. Temperatures decreased February through March allowing snow at sea level. Avalanche activity occurred mostly with storm snow and rain-on-snow events. No avalanche accidents were reported, and no debris reached the highway. A level 1 course in February educated nine students. From October 1st to April 1st, 1.6m SWE fell. At mid mountain (~1500 ft), the average temperature was +0.27°C and the maximum HS reached 2.78m. This was the coldest winter and the highest snowpack in eight years.

— Steve "Hoots" Witsoe



The **Bridgeport Avalanche Center** reinvented itself for the winter 2020-2021. A grant funding windfall enabled four staff members to team up to provide a consistent, reliable stream of snowpack summaries and observations from December through mid-April. Despite operational challenges imposed by Covid restrictions, unprecedented low snow conditions and generally awful skiing conditions, we posted 36 snowpack summaries, 72 observations, and taught three avalanche awareness classes for snowmobile users in a short two-and-a-half-month season. The short field season in the sled-access only Bridgeport Winter Recreation Area (BWRA) encouraged us to expand our coverage area into the Virginia Lakes watershed. We are a small center but plan to provide a wider range and number of advisories and observations in 2022. We are pleased to have the support of our newly formed Friends of the Bridgeport Avalanche Center.

Bridgeport Winter Recreation Area

The Bridgeport Winter Recreation Area was officially created by Congress in 2010. It is the first Federally designated winter motorized recreation area in the nation. The BWRA is a small 7,254-acre area that includes the headwaters of the West Walker River and is blessed with more snowfall and deeper snowpacks than Mammoth Mountain. Elevations range from 7,200 feet to over 11,000 feet along the Sierra Crest.

The BWRA is accessed by riding State Highway 108 from People's Gate, elevation 7,200 feet. Most riders congregate in the open bowls south of Leavitt Lake, elevation 9,300 feet. In 2021, Highway 108 was snow covered from People's Gate to the higher elevations for about 20 days. The lower two to three miles of Highway 108 were mostly bare asphalt. Winter riders and staff had to contend with conditions shown in the photo below. Motorized use in the Bridgeport Winter Recreation area declined this season to 550 permits issued to riders in from the end of January to mid April compared to five-year average use of 770 permits for January through mid April.

Accomplishments

For the first time ever, the BAC had full staffing thanks to funding from the California OHV program. Grant money funded two avalanche specialists, a snow ranger, and an OSV coordinator/avalanche specialist.

After years of Andy Anderson's much appreciated upgrades and webmaster services, the OHV grant provided funds to hire a new webmaster who began the process of reorganizing the entire site in May 2021.

2,000 sled miles were logged; close to 900 miles were on asphalt. The demand for scratchers was high.

Difficult access to the BWRA provided time to rewrite JHA's operations plans and volunteer agreements. Consultation with Brandon at the Sierra Avalanche Center and Simon Trautman from the NAC

provided guidance on the numerous requirements and hurdles to overcome as we proceed to grow a reliable and consistent operation.

BAC staff gave three awareness classes geared to snowmobile users. We reached 30 people this year—not many compared to centers with large population bases but not bad for the first year in a region with a population of 2,250.

In mid-May 2021, we meet with the newly recruited members of the Friends of the Bridgeport Avalanche Center. A Friend's group will help stabilize funding, allow donations of sleds, cash, and gifts, and decrease our reliance on OHV grant money to run a sustainable avalanche program.

Season Highlights

Due to Covid-19, the crew met virtually for daily morning forecaster/patroller meetings. Morning meetings anchored field operations: we shared and discussed daily weather forecasts and avalanche concerns while planning field days and telework. We tried to schedule five days of field work in the BWRA and Virginia Lakes areas but difficult access made getting to the field challenging. Sled maintenance and occasional outbreaks of telework assignments also limited access to the field.

Relentless high pressure located off the California coast shunted storm after storm to the Pacific Northwest, leaving the backcountry of the Bridgeport Ranger District with dismal snow cover in the mountains. A wild weather week at the end of January resulted in epic eastern Sierra snowfall that kick-started a late ski season. In February the momentum sputtered and only two storms with 12 inches of snow occurred until the season ended in mid-April.

Chris Smallcomb, Warning Coordinator from the NWS Reno office provided a virtual interactive presentation in early January. Chris presented the various teleconnections that would sadly lead to a dry winter. BAC staff also learned about

Overview of the Bridgeport Winter Recreation Area at the end of March, 2021.





A CalTrans dump truck after an avalanche pushed it into the West Walker River, January 29, 2021.

weather model products that are useful in an operational setting and GOES-17 satellite bands to track storm paths.

Treacherous skiing conditions with an overabundance of rocks characterized December and January field conditions. A few small early season storms and a shallow, 30 cm snowpack consisted of small facets with occasional depth hoar.

The first half of January didn't feel like winter. Daytime highs were in the upper 40s and while nighttime temperatures were in the teens, the weak facets began to round, then reverted back to facets as colder temperatures prevailed during the last week of January.

The ski and riding season finally began at the end of January. A powerful and cold atmospheric river dumped four to five feet of snow in two days from the valley floors to the Sierra Crest. Highways were closed, snow removal equipment on the Forest Service compound was stuck, and large unusual avalanches damaged property and buried a CalTrans snowplow operator on the main highway connecting eastern Sierra communities to the Reno area, Figure 4. Five feet of snow in 48 hours drove the avalanche danger from none to High in less than 24 hours. Numerous large avalanches occurred in the storm snow that fell on bare ground and at the old snow/new snow interface.

The BWRA opened on January 29 2021 with four feet of snow on the ground at People's Gate and almost 100 inches of snow at Leavitt Lake. Snowmobile trailers lined both sides of the road at People's Gate and over 200 riders enjoyed excellent riding conditions during February.

Only eight inches of snow fell at Leavitt Lake in February and clear

days with several high wind events created variable surface conditions and difficult travel on skis and sleds. Longer days and higher sun angles during the last week of March finally created more user-friendly spring-like conditions. Most of the season's avalanche activity occurred as wet loose at the end of March and April, with a few small wet slabs observed.

At the mid-elevations, night time temperatures at 9,000 ft. were above freezing and mid elevation snow was disappearing quickly. Higher elevations had plenty of skiable terrain as the March 29 2021 photo shows. Two weeks later, the BWRA closed early due to patchy and sparse snow cover at the lower elevations. Despite low snow at low and mid-elevations, spring skiing conditions remained good through May.

— Sue Burak

BTAC

The **Bridger-Teton Avalanche Center** noted that last season's storm track heavily favored the Teton Range and to a lesser extent the higher elevations of the Togwotee Pass and Greys River areas. Season snowfall totals for the Tetons ranged from 400 to 550 inches. The upper elevations of the Greys River and Togwotee Pass areas received 320 to 380 inches while the mid and lower elevation of those outlying areas only received 250 to 270 inches. Valley locations received around 180 inches.

Snow began to accumulate in the mountains in mid and late October. Record cold temperatures (-9 degrees F) occurred on October 26. After some more snow in early November conditions were mostly dry

from mid-November into mid-December. This scenario created a persistent weak layer that became a problem when snow began to fall again. The first avalanche fatality of the season occurred on that layer on December 18. Small to very large persistent slab avalanches occurred during storm cycles in the second half of December and in January. Record snowfall occurred during the period from January 27 to February 26 (205 inches of snow with 13.5 inches of snow water equivalent at the Rendezvous Bowl Snow Study Site). The rest of the season was very dry. Consequently, the maximum snow height for this season occurred on February 20. Maximum season snow depths typically occur in March, April, or early May.


Most of this season's avalanche events occurred from mid-December through February. Spring conditions that involved the development of thick melt-freeze crusts were quickly established in March and continued until the end of the season. Snow depths in June were comparable to typical July snow depths. Air temperatures were well above normal in December, above normal in January and March and below normal in February.

There were 28 people who were reported to have been caught in

avalanches in the backcountry. Of those 18 were partially buried, three were fully buried, three were injured and four were killed. Three of the four fatalities occurred during a five-day period in February. The other occurred on December 18. Two of those killed were snowmobilers. The other two were snowboarders. In all four of these tragic instances it could be stated that those involved underestimated the terrain given the snowpack conditions.


The backcountry in western Wyoming experienced huge increases in users. Trailheads experienced record crowds especially during the first several months of the season when other areas were experiencing low snow conditions. The Wyoming State Trails Program sold out their trail fee stickers in February and had to order more.

New technologies employed by the center for this season included significant upgrades to our web-based snowpack tracker and storm tracker products. We also pioneered the use of story map geographical information system (GIS) technology. This technology was used in our December 18 video avalanche fatality report that can be viewed at <https://storymaps.arcgis.com/stories/43abc8c193324aaf9819ffd2613aa6c4> This story map format



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combines text, photographs, video images, a snowpit profile, and GIS mapping tools into its account of this avalanche fatality. It is necessary to use Chrome as a browser to view story map products.

Other efforts included the development of tutorials which provide detailed information about many of the avalanche analysis tools that exist on our website. Those tutorials are accessed from a button located in the top right portion of our homepage. Additional tutorials will be added for next season.

Our partnerships remain strong. The Wyoming State Trails Program continues to provide funding for avalanche education efforts in outlying areas of the state, is providing the center with a new four place snowmobile trailer and continues to fund a significant portion of our field work. The Grand Teton National Park Foundation continued to provide funding for a full-time, seasonal avalanche forecaster through Grand Teton National Park. Our center continues to work closely with the avalanche safety programs



at our local ski resorts and help to support the operations of specialized automated avalanche weather stations at those resorts. We also continue to work closely with our local National Weather Service office. The Bridger-Teton Avalanche Center Foundation hugely supports our program and enabled us to participate in a sled loaner program with Ski Doo. Nearly 70% of our annual operations costs are derived from sources outside of the forest.

— Bob Comey

And as you can see from the photo, it snowed a lot in February in the Teton. This figure provides three panels from our snowpack tracker product. These panels display daily data for the period from October 1, 2000 to June 18, 2021. The middle panel is comprised of snow data from the Rendezvous Bowl Snow Study Plot. The lighter blue line depicts the daily snow height at that location which peaked on February 20. The dark blue bars represent hand measured daily 24-hour snow totals. The light blue bars represent hand measured daily 24-hour

snow water equivalent totals. The yellow bars represent daily snow depth settlement totals. Due to a program issue those yellow bars are not visible on this graph during the first half of the season. The periods of early season snowfall, period of record snowfall from January 27 to February 26 and the dry conditions that ensued after March 1 are easily recognized on this panel. The bottom panel displays the number of backcountry avalanche events per day that were reported to the avalanche center. Most of that avalanche activity occurred from mid-December through February. The upper panel displays the daily avalanche hazard in the Teton area.

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CAIC

The 2020–21 avalanche season in Colorado was marked by 12 avalanche deaths, the most recreational avalanche deaths since 1992–93, and double our 10-year average. Only pre-WWII mining days saw seasons with more avalanche fatalities. There were 5019 avalanches reported to the Colorado Avalanche Information Center (CAIC) during the season. We documented 82 incidents with 94 people caught in avalanches, exceeding the 10-year median of 56 incidents and 84 people caught. This included five multiple-involvement accidents and two multiple-fatality accidents.

Our seasonal snowpack began to develop with a healthy storm from October 24 to 26. November had three storm events, and each produced an uptick in avalanche activity. Despite few areas with enough coverage for on-snow travel, seven people were caught in small avalanches. We ended the month with cold clear conditions, which extended into the first 10 days of December.

During this dry weather the upper portion, or even entire snowpack, turned into cohesionless faceted

grains. While early-season snow changing into well-developed facets and depth hoar is common in Colorado, this season was particularly pronounced. The basal weak layers were thicker and more continuous across the terrain. We knew we were in for trouble once a slab formed on this very weak foundation.

Snowfall returned on December 10, and we recorded 93 human-triggered avalanches in the following week. This is the most human-triggered avalanches we've recorded in a week. Most were small, size D1, due to low snowpack volume. As more snow accumulated, the avalanche size slowly increased. The next week we recorded 83 human-triggered, the second largest number of human-triggered avalanches recorded in a week. On December 18 we had our first fatal avalanche accident when a solo backcountry skier was caught, buried, and killed in an avalanche west of Crested Butte. This accident began to characterize our victim demographic of fairly experienced males over 40 year old.

The next day, two backcountry skiers were caught, buried, and killed in an avalanche southeast of Ophir. Again, this accident involved two experienced males over 40. Only about 5% of fatal avalanche

accidents in Colorado occur within two days of the previous one. More ominously, this was the first of five multiple-victim avalanche incidents in Colorado, and 15 nationally, to occur throughout the season. By December 20, seven other people triggered and were caught in avalanches with less tragic consequences.

Tragedy struck again on December 26 when a solo backcountry skier north of Berthoud Pass triggered a fairly small avalanche, which swept him through a narrow rocky chute. Again, a male victim over 40.

The month ended with another storm, and we recorded 427 natural and human-triggered avalanches in the four days between December 28 and 31. Avalanches were now breaking deep and wide, and were an ominous sign of things to come. Avalanche conditions were as bad as we've seen in about a decade. We issued the first of several video PSAs warning of the unusually dangerous conditions.

In January the trend of avalanches increasing in size continued. We also continued to see many avalanches remotely-triggered by backcountry travelers, some as far as a thousand feet away. January 8 was a spectacular day for large avalanches, with three separate close calls involving D2 and D3 remotely-triggered avalanches, all caught on video.

Dry weather during the middle of January produced a new weak layer on the snow surface. The first real test of this layer arrived with a storm system on January 18. It failed miserably, and we saw a widespread cycle of natural and human-triggered avalanches. There were a few incidents but all escaped unharmed.

February 2021 will be remembered for all the wrong reasons. During this month we saw the highest number of people killed in avalanches across the United States in over 100 years. In Colorado, avalanches killed seven people, the most in one month since February 1987 and one of the three worst months since 1950. The month got off to a terrible start. In just the first week, 12 backcountry riders were caught in avalanches and four lost their lives.

Four people were caught and buried, and three people were killed in a single event on the first day of the month. All three victims were males over 40. A group of seven backcountry skiers northwest of Silverton, near Ophir Pass, had just arrived at a hut for a multi-day trip. On the afternoon of their arrival they set out for a short ski tour when the group triggered a large avalanche from the bottom of the slope. The group rescued the one partially buried-critical victim, but the other three victims



An annotated image of the February 1 avalanche on Ophir Pass taken on February 2. The yellow line indicates the group's second ski run down to the knob before descending into the gully at the bottom of the photo. **The group triggered and were buried by the avalanche outlined in red.** Avalanches that ran sympathetically are outlined in green and brown. Blue circles indicate the approximate burial locations of Riders 1 through 4. The large avalanche to the looker's left of the fatal avalanche was triggered by explosives to protect searchers.

were buried three to six meters deep. Because of the exceptional burial depth, recovery for the other three victims required a multi-day, multi-agency effort, including several agencies from San Juan County.

A potent storm arrived a couple days later on February 3, prompting an Avalanche Warning for portions of the Central Mountains. The next day, we experienced the second fatal avalanche accident of the month in the East Vail backcountry involving another male over 40 years old. This avalanche broke 700 feet wide.

After a brief lull in snowfall, a series of storms brought snow back to Colorado on February 11. The snowy pattern and dangerous snowpack conditions coincided with a busy President's Day holiday weekend. We issued another PSA video on February 12 as our worries grew. We have a regrettable pattern of tragic accidents around Valentine's Day, and this year was no different.

On February 12, three riders were caught in an avalanche near Monarch Pass, and fortunately escaped without injuries. On February 13, a snowboarder was fully buried in an avalanche in East Vail. Fortunately, his partner executed a swift recovery. On Valentine's Day, February 14, the luck would run out.

Late that morning, the Clear Creek County Sheriff reported a large avalanche with a person missing on Mt. Trelawney just east of the Eisenhower Johnson Memorial Tunnel. CAIC Forecasters assisted the Alpine Rescue Team in recovering a deceased avalanche victim. The victim deployed his airbag but he was traveling alone and without a beacon (see photo page 31). While on this scene, Grand County authorities notified the CAIC of another accident in the Front Range zone near Rollins Pass, east of Winter Park. A snowmobiler triggered an avalanche and was caught and carried on to a lake, breaking the ice. The rider was pinned under the snowmobile in a slushy mix of avalanche debris and water. His partner was unable to free

him and the snowmobiler did not survive. The last time Colorado experienced two fatal avalanche accidents on the same day was February 10, 2014. Both Valentine's Day victims were males over 40.

On the afternoon of February 16, six snowmobilers were riding northeast of Willow Creek Pass in the Never Summer Range. They put several tracks on a lower-angle slope with steep slopes overhead. One rider stopped in the middle of the slope, and soon after, an avalanche released, breaking over 3000 feet across, partially burying one rider and catching, carrying and completely burying a second rider at the

bottom of the slope. The buried rider was not wearing a beacon, and the party was not able to find him with spot probing. A team from Colorado Rapid Avalanche Deployment used an avalanche rescue dog to locate the deceased victim the next day. The victim was another male over 40.

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A depiction of the billboard design that CAIC deployed around the state in March 2021.

Storms and snowpack instabilities eased for the remainder of February, but we remained on edge. We expanded our toolbox to try and connect with harder-to-reach users. We deployed billboards around the state and aired public safety messages on commercial television in early March.

Avalanche conditions were less dangerous throughout March, but we were still plagued with persistent weak layers in the snowpack. We saw some notable storms, including a potent upslope that brought feet of snow and desert dust in the middle of the month. Despite some close calls we made it to March 22 before our final avalanche fatality of the season struck when a skier was killed in an avalanche in extreme sidecountry terrain after exiting the Beaver Creek ski area. The avalanche released from a small part of the start zone and swept the victim over a cliff.

By early April, spring warm up really took off. Unseasonably warm temperatures pumped prodigious amounts of water in the snowpack, and sparked one of the most pronounced wet slab avalanche cycles in recent memory the first week of the month. Melt continued more or less unabated into May and melt was about a month ahead of schedule as the seasonal closures on the high mountain passes opened.

We hope the historic numbers of avalanche fatalities, multiple-involvement accidents and multiple-fatality accidents are just anomalies and not the sign of a worrisome trend.

—Brian Lazar,
 Deputy Director of the CAIC

CBAC

This was a tragic winter for many mountain communities around the West. An especially challenging snowpack collided with a boom in backcountry use, spurring the most avalanche fatalities that the U.S. has seen since thorough record-keeping began in 1950. The twelve fatalities in Colorado this winter season

matched the previous high water mark set in 1993, and more than doubled the recent five-year average. Our valley was not immune from tragedy.

This winter the **Crested Butte Avalanche Center** documented about twice the average of large avalanches compared to the past five years. The smoking gun wasn't an exceptionally stormy winter. In fact, the Gunnison River Basin peaked at only 86% of average. Rather, the culprit was a pair of unusually prolonged droughts, one that ended in mid-December, the other that stretched through much of January. These dry spells caused the formation of exceptionally fragile weak layers, even by Colorado standards. The erratic and unusual behavior of these faceted layers continued to surprise even the most veteran backcountry travelers and spurred natural avalanches through much of the winter.

A 17-day dry spell ended on December 10th, causing our early season snowpack to deteriorate into one of the worst facet layers our staff can recall. Avalanche activity raged through the last three weeks of December as this layer was first buried by shallow slabs. We saw an impressive three week streak of dangerous conditions, during which time upwards of 4" of SWE accumulated. The month saw an unprecedented number of human triggered slides - over 90 in the Crested Butte area. Many of the slides were remotely triggered. December also brought the only two accidents that involved organized rescue of the winter. A skier broke his leg after getting swept into trees on Snodgrass Mountain, and Jeff Schnoid, a former ski patrolter and long-time local backcountry icon was fatally buried while skiing solo near Ohio Creek Pass.

A few more close calls followed in early January before the snowpack transitioned into its second major dry spell and lull in avalanche action which lasted over two weeks. The danger then crescendoed during a prolonged snowy period in February that added up to 7" SWE over the course of 23 days, resulting in more than 325 D2 and D3 natural avalanches. Avalanches broke on the mid-pack facets formed by

January's drought and on December's depth hoar layer. In what was the most bizarre demonstration of this stratigraphic nightmare, we observed a persistent slab release on the mid-pack January weak layer one morning, only to subsequently release a second slab breaking near the ground later that day...across the same start zone. Seven of our eight high danger days fell in February. Although February was by far the deadliest and most dangerous month for both Colorado (seven fatalities) and the rest of the country (26 fatalities), CBAC's strong messaging and outreach efforts appeared to be well heard. There was only one small avalanche triggered by the public and no public involvements during this exceptionally challenging month. The handful of human triggered slides in February were either triggered by professional snow safety teams or intentionally by our forecasters. The only near miss reported in February was a full burial and successful rescue that took place during mitigation work at Irwin.

The snowpack adjusted to quieter weather in March, with fewer and smaller avalanches but an uptick in human involvements. March saw several close calls as skiers and riders pushed into more aggressive terrain, perhaps letting their guard down after a disciplined winter. Most of the notable triggered slides in March occurred on repeat offender avalanche paths, where previous avalanche activity left the snowpack weaker and shallower than adjacent terrain.

A record-setting heat wave in the first week of April produced one of the more impressive wet avalanche cycles in recent history, with an ongoing string of large wet slabs and deep gouging wet loose slides for several days. The danger subsequently dropped to Low for the remainder of CBAC's operational season due to better refreezes, quiet weather, and a mature spring snowpack. There were no incidents reported in April.

The flurry of accidents in Colorado during the spring of 2020, sold-out avalanche classes, and exploding backcountry gear sales all gave clear warning that this winter would be especially challenging. Here are a few new operational and outreach improvements that we deployed in anticipation:

- **Outreach Program:** We staffed two new outreach positions to spearhead our outreach efforts, which included a virtual speaker series, youth outreach classes, radio programming, an online series of rescue videos, and trailhead outreach days. CBAC's outreach efforts were recognized nationally in a piece by National Public Radio.
- **Website:** We implemented the new NAC website platform which improved our media capability, mobile optimization, and consistency with other centers around the country. Our website stats show a 67% increase in unique visitors since last year.

Forecaster Zach Guy playing the old "Who's taller?" game with a deep slab on Schuylkill Ridge. February 15, 2021. ■ EVAN ROSS





Outreach Director Ian Havlick teaches rescue skills with a group of students in Crested Butte. ZACH KINLER

- **More forecast zones:** The CBAC divided its forecast region into two smaller forecast areas to highlight spatial differences that frequently develop between the snow-favored and snow-starved portions of the Elk Mountains.
- **Field Presence:** We aimed for a stronger field presence to improve our forecast accuracy. Together, the forecast and outreach staff submitted 252 professional observations from the field this season, a 45% increase from last year. A few of these were made from small aircraft following notable avalanche cycles.
- **Social Media:** Along with almost doubling the number of social media posts, we also began posting stories to each platform as a way of communicating relevant and timely avalanche activity and observations. These were a big hit.
- **Trailhead Days:** A major addition to this year's outreach, CBAC staff set up information booths and interacted with the public at popular trailheads throughout the winter. This was a fun and effective way of engaging with all types of users and demographics, and feedback was overwhelmingly positive.
- **Avalanche Danger Sign:** The CBAC installed a large sign that displays the current avalanche danger near the entrance to town, similar to fire danger signs. Staff updated the sign every morning by 7:30 a.m.

—Zach Guy
Lead Forecaster

CNFAIC

As with the rest of the world, the 2020–21 season was anything but ordinary for the **Chugach National Forest Avalanche Information Center**. We faced challenges due to severe weather (and lack thereof), operating in the pandemic era, and several tragic accidents. We are lucky to have a broad network of avalanche professionals to collaborate with in our area, including the Alaska DOT and Railroad Avalanche Programs, Alaska Guide Collective, Alyeska Snow Safety, Chugach Powder Guides, Alaska Avalanche School, Chugach Electric, and the Hatcher Pass Avalanche Center. Through the support of our tight-knit forecast team, the collaboration with our professional avalanche partners, and our non-profit Friends group, we were able to stay safe and healthy for another successful (albeit unusual) season.

Highlights

The season started off strong. Heavy snowfall in November enabled the Chugach NF to start opening motorized areas by Thanksgiving weekend. The stormy weather continued through the next two months, and by mid-January we had over 11 feet of settled snow on the ground. Most of the precipitation fell as snow, putting the snowpack at around 160% of the 1981–2010 median values. This buried the lower-elevation alders and provided some of the best coverage we have seen in the past decade. With one storm system followed by another through the end of January, folks were eventually pining for a clear day to get out

farther into the mountains. Skies did clear as the faucet shut off abruptly for February and March, and we traded ample snowfall for a string of wind events. Luckily, the core of our advisory area was spared from the majority of the damaging winds, and below-average temperatures maintained great riding conditions well into April. Springtime made a dramatic appearance starting April 15, as we received 2–5' of snow over four days, which was immediately followed by clear skies with ridgetop temperatures reaching up into the 50s F. Needless to say, we saw a heck of a spring shed cycle complete with just about every avalanche problem. After the mountains had several days to adjust, clear skies and cool nights provided solid refreezes and a bountiful corn harvest.

Lowlights

Southcentral Alaska had two separate fatal avalanches this season, resulting in four deaths. Neither incident occurred within the CNFAIC operational area. The first accident occurred on February 2nd in Chugach State Park just outside of Anchorage, claiming the lives of three climbers as they were caught in an avalanche while ascending a steep, 2500' gully. The second occurred on March 27th, when a ski-

er was caught in an avalanche in the mountains close to the toe of the Matanuska Glacier. In addition to these avalanche accidents, five people lost their lives in a helicopter crash near the Knik glacier on March 27th. This accident was also a tragic loss to the outdoor community as it included two ski guides and a pilot who had been involved with heli-ski operations in Alaska for years. Our condolences go out to the families and friends of those who perished. (Editor's note: see page 16 for obituaries of the two ski guides, Greg Harms and Sean McManamy.)

Challenges

In order to stay open while minimizing the risks posed by Covid-19, we made some changes in our daily operations. This included a daily screening questionnaire for all field partners, transitioning all office work to be done remotely, assigning one vehicle to each forecaster for the entire season, wearing masks at all times when indoors or when unable to maintain 6' distance outdoors, and eliminating carpooling until all passengers were fully vaccinated. It also meant we had to hold all outreach events virtually. This included the Southcentral Alaska Avalanche Workshop, the annual fundraiser for our Friends group, and a

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Large remote-triggered avalanche on Tincan's Hippy Bowl (SS-ASr-R3-D2.5-0). The slide was triggered by a skier on the lower-angle slope adjacent to the avalanche. The pocket in the lower right of the frame released sympathetically. The three pockets on the left side of the frame released in the previous 24-48 hours, during the middle of a storm that brought over 2' of snow equaling around 2" SWE on top of a layer of surface hoar and near-surface facets that had formed during a clear spell in the five days prior to the storm. ■ HENRY MUNTER



'Forecaster Chat' series which consisted of four separate evening discussions about different topics in the world of snow and avalanches. While there are obvious drawbacks to hosting all of these events virtually, we found a silver lining in the ability to host avalanche professionals from across Alaska and the lower

48 to share their research and experiences. We are hoping to use some type of hybrid format for virtual and in-person presentations for outreach events in the future.

Staff

Internal operations at the CNFAIC began with welcoming Andrew

Schauer as our new third forecaster, rounding out the team of Aleph Johnson-Bloom (Lead Forecaster) and Wendy Wagner (Director). Andrew cut his teeth in Montana working with the West Central MT Avalanche Center and the Gallatin NF Avalanche Center. He is no stranger to Girdwood or Turnagain Pass, however, and is working now on terrain complexity maps for our region. Aleph took on a plethora of behind-the-scenes work, and much of the center's success can be attributed to her efforts. After six seasons working for the CNFAIC, Aleph will be stepping away from forecasting to pursue other opportunities. Her presence will be seriously missed, and we wish her all the best in her new endeavors. Graham Predeger has stepped back to an ambassador role. He pinch-hit a couple forecasts, an outreach event, and joined us on a handful of choice ski and snowmachine missions.

With the books closing on this not-so-ordinary season, we'd like to extend a sincere thank you to our Forest Service leadership and our Friends group. The Friends of the CNFAIC provide just over half of our operating budget. We could not survive without their incredibly hard work and their partnerships with our local industries, businesses, members and donors who provide the funds and support to keep the CNFAIC moving forward!

— Andrew Schauer

COAC

Overall, we had a great season at the [Central Oregon Avalanche Center](#).

The snow began stacking up in November and many of the locals had a good number of powder days under their belt before December 1st. Our season was characterized by great ski quality and fewer days with Considerable danger than is typical for the region. We had relatively few 'monster' Pacific storms that drop a meter of snow. Our weather was more often from the northwest (our wind and storms typically track from the southwest and west) and this kept us colder and drier, with frequent snow accumulation trickling in. While we operate in a maritime snow climate, we will typically deal with one or two persistent weak layers throughout the season; however this year the term 'persistent slab' was seldom heard. It is Oregon after all, and we did see a few rain events all the way to the upper elevations from time to time.

The avalanche center has been improving the forecasting program each season and this year saw major progress. In previous seasons, COAC had been issuing biweekly advisories. For the 20-21 season we stepped it up and issued forecasts Friday through Monday each week from December 1 to April 30. We chose this schedule in order to have information available to the public when most people were out touring. Currently, COAC does not have the budget to operate seven days/week.

Our team integrated the avalanche forecast platform from the National Avalanche Center. It definitely made our job easier, and provided better and more consistent avalanche information to our users. Thank you to Simon Trautman at the National Avalanche Center and everyone that helped to make that an easy transition for us.



Some of the prized terrain in central Oregon: the Three Sisters and Broken Top. ■ AARON HARTZ

Our forecast operations were relatively unaffected by the pandemic. The more popular Snoparks were often jammed full, which made for some fun work-arounds and exploration of new terrain. Central Oregon has experienced a growing backcountry user group over the last decade and the parking scene reached a tipping point this year, although by late February even the most popular venues began to quiet down.

Fundraising had a new twist this season with all events being remote/virtual. Starting in the fall we put on the 3rd annual Bend-SAW with a great lineup of speakers including Margaret Wheeler, Sarah Carpenter, Collin Zacharias, Pascal Haegeli, and more. Audience members could submit questions during the talks, and this sparked some great discussion with the speakers. Even though it was a remote event, it still had a very personal feel to it.

COAC also carried on the tradition of the “Fresh Tracks” party and silent auction (minus the party). The silent auction was virtual and went as well as we could have hoped for. The last and probably most unique event was the “Vert Fest” uphill/downhill race. This took on a new format during Covid era. Instead of a single race day, participants had nine days to rack up as much vertical as they could on skis or snowboards. The vert was recorded using the Strava app or other similar tracking apps. This was a huge success with people competing not only in central Oregon, but all across the western states. At the beginning of the season we were unsure how fundraising events would work out during the pandemic. Fortunately the community made a strong showing and the events went off better than we expected.

As of mid May, the alpine terrain was still in prime shape for ski mountaineering season in the 3 Sisters region and on the volcanic peaks all along the Oregon Cascade

range. We hope everyone has a great remainder of the year and we look forward to being back in action in December 2021.

—Aaron Hartz and Gabe Coler

ESAC

If you could categorize a winter as a “one storm wonder,” the 2020–2021 winter in the Eastern Sierra came pretty close to hitting the mark. Like many mountain ranges of the western U.S., modest early season snowfall occurred in November and was followed by a long stretch of clear, dry weather. While many continental forecasting centers often deal with the type of persistent slab issues that comes from this weather pattern, the **Eastern Sierra Avalanche Center**, with a typically maritime snowpack, is much less familiar with the phenomenon. Small storms in December provided barely enough coverage for backcountry travel and limited travel to the northern half of the forecast region. Meanwhile, facets continued to grow. Savvy eager beavers anxious to ride steeper lines paid close attention to what slopes had been stripped clear of the November snow by winds and sun and chose to stick to those, rolling the dice with low-tide sharks rather than potential wind drifts on top of facets. Dry and spring-like weather for most of January continued to degrade and facet the snowpack, but without enough of a concerning slab on top, LOW danger prevailed.

The show-stopper storm-of-the-season occurred January 27–29, dropping over 100” of snow in the northern half of the forecast zone. Avalanche Warnings were issued, and at the height of snowfall intensity on the 28th, avalanche danger spiked to EXTREME. Impressive large natural avalanches occurred, one of which struck a Cal-Trans

plow on HWY 395 and pushed it into the Walker River (see photo page 38.) One of Mammoth Mountain’s guests suffered a deep-snow immersion in the middle of a run only a few hundred feet from the bottom of a chair lift, and tragically could not be rescued in time. A couple of days following this storm, the worst avalanche accident of the season occurred when a well-known ESAC board member triggered and was caught and carried in a large Persistent Slab avalanche on Punta Bardini. The skier was injured and hospitalized, but very fortunately survived. This led to some heated community discussion. ESAC responded with a live, in-depth debrief of the accident. All of the parties involved were present, and they each offered their own perspectives of what led to the accident and what they learned. This important debrief reminded the public that everyone is human and susceptible to biases, and being involved in the avalanche industry, even at high levels, certainly doesn’t make one immune to an accident.

As the snow settled from this big storm, continued propagating test results and slope collapses kept av-

alanche danger elevated for eight days with Persistent Slab concern, but there was no further avalanche activity after the Punta Bardini incident. Forecasters finally felt comfortable dropping danger to LOW on February 7, and dropping Persistent Slab from the discussion altogether on February 10. A long stretch of dry weather ensued with devastating winds, and although there was finally a solid base to ski on, the conditions were less-than-inviting firm wind-board, breakable crust, and sastrugi. Surface faceting in sheltered trees provided refuge for a while, until all the sheltered areas within a few hours of a road got tracked out. Finally, a consistent pattern of small storms set in for two weeks in the middle of March offering some of the best skiing and riding conditions of the season. April ushered in the spring-time corn harvest, and despite a relatively thin, shallow snowpack, more good turns were had as well as a few close calls with Loose Wet avalanches. ESAC is thankful for another season without a single avalanche fatality.

As with most operations across the country and world, Covid had a large effect on ESAC’s education

Backcountry use was greater than ever before in the Eastern Sierra, despite the unusually low snow year. Parking areas at popular trailheads were packed to capacity and crowded slopes (at least for Eastern Sierra standards), such as the SE face on Dunderberg Mountain on April 8, were not uncommon. ■ JOSH FEINBERG





SKI GUIDE BIB

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and outreach programs. Instead of the popular in-person events that the public had gotten used to, ESAC produced virtual events through Zoom. Although not as intimate, these events were quite successful, reaching a far larger audience than ever before. Our series of monthly Backcountry Avalanche and Travel Education events attracted over 650 live virtual attendees, and the recorded events had over 1600 views. ESAC's board got creative with its annual Season Kick-Off Extravaganza, and threw an outdoor drive-in movie style event at Bishop's Tri-County Fairgrounds on December 5, with an option to attend virtually. Other virtual events included avalanche awareness for 3rd and 5th graders at Bishop Elementary, Inyo & Mono County Search and Rescue Groups, CA Dept of Water Resources, our annual Interagency Avalanche Round Table meeting, and guest appearances for local AIARE courses.

Despite challenging weather (or rather "lack" of weather), this was perhaps the Eastern Sierra's Avalanche Center's most successful season yet. Operating independently since 2015, the Center's success is in no small part due to the leadership and motivation of ESAC's nine dedicated board members. For the first season ever, ESAC's three full-time forecasters were hired as direct employees rather than independent contractors. Also for the first time, ESAC hired two part-time support staff: an Education and Outreach Coordinator and a Grants and Fundraising Administrator. ESAC began operations this season at the beginning of December, issued its first Snowpack Summary on December 13, and issued daily Avalanche Advisories from December 21 through April 16.

—Josh Feinberg

GNFAC

At the Gallatin National Forest Avalanche Center, all winter we talked about weak, sugary snow near the base of the snowpack creating unstable conditions. From late October through November the mountains received 2-4 feet of snow. Mostly dry and cold weather through mid-December caused the early season snow to become faceted and weak. From late December through mid-January, steady light snowfall and wind formed slabs above the weak snow. Signs of instability like collapsing and cracking were widespread. Avalanches 1-3' deep were triggered by skiers

and riders and broke naturally. Activity peaked during and after an avalanche warning on January 5th, and more human triggered and natural avalanches occurred through mid-January.

Although Cooke City had fewer avalanches break on facets near the ground compared to the rest of our area, on January 8, three skiers from a group of six triggered and were caught in a large avalanche on The Fin. Two were injured with one requiring helicopter evacuation (see photo page 28).

Nearly dry conditions during the second half of January gave the snowpack a break. The first few inches of snow at the end of January elevated the avalanche danger to considerable. On January 30th skiers remotely triggered a very large avalanche in the southern Madison range, and widespread collapsing and unstable test scores continued throughout the advisory area.

The first week of February had continuous heavy snowfall. We issued an avalanche warning for the Bridger Range on Feb 5 and for most of the advisory area on Feb 7. Natural and human triggered avalanches occurred everywhere.

A brief dry period allowed danger to decrease to a spicy moderate as human triggered avalanches continued to break on the weak snow near the ground. Tragically, on February 14, a splitboarder was killed in one of these avalanches in Beehive Basin near Big Sky.

Heavy snow returned and we issued an avalanche warning for the mountains near Bozeman and Big Sky on February 17. Loading rates were less than storms earlier in February and we saw less avalanche activity as snowfall became less frequent. Then strong winds drifted snow and tipped the scales of the weak snow near the ground. In Hyalite, natural avalanches broke 4-10' deep in the now average, deep late winter snowpack, and near Big Sky a snowmobiler triggered a 10' deep avalanche.

Avalanches breaking on weak snow near the ground became infrequent as snowfall continued at a slower but steady rate through the end of February. On the final days of February, a snowmobiler triggered a 3-4 foot-deep, relatively very large avalanche on the weak snow near the ground, and skiers that were filming and hitting a jump triggered an avalanche on the slope where they were landing. It broke 4-6' deep, 200' wide and sympathetically triggered another similar slide 300' away. Luckily, nobody was caught in either of these incidents.

In the first half of March warm and dry weather turned our concerns to wet avalanches and weak

layers forming on the surface. A week into March it became unlikely to trigger a deep slab avalanche and danger was low. Snowfall became more frequent, but modest storm totals kept our primary concerns to avalanches breaking within the new snow and on weak layers that formed in early March.

By the end of March, a week of snow totaling 2.5-3 feet ended with a skier remotely triggering a 50' wide, 8-12' deep slab avalanche in Hyalite, and a natural 3-5' deep slab avalanche was reported nearby. Three days of strong wind followed this storm, with gusts of 60-100 mph. Danger rose to Considerable and there were plenty of wind slabs, but no more deep slabs.

April began with above freezing temperatures and sunny skies, and our concerns shifted back to wet snow. Most nights had near freezing temperatures and clear skies which kept avalanches to shallow loose snow slides. Danger dropped to low on April 8. Avalanche hazards were limited to small drifts and loose snow avalanches. We issued our final daily forecast on April 11.


The pandemic forced us to make significant changes, mainly to our education program. The Friends of the Avalanche Center group works closely with the GNFAC to bring

quality avalanche education to the public. Education Coordinators Jodi Redfield and Nina Hance brought most of our avalanche education online, which was no small feat. This was Nina's last season with the Friends and Shannon Regan was hired as her replacement. Nina was (co-)coordinator for the last four winters and successfully expanded the avalanche education program. We all benefited from her expertise and enthusiasm.

This was one of the worst years for stability with no time or space to step out carelessly. The support from our Friends group, the local community, and the Forest Service, with some luck of course, prevented many more accidents.

GNFAC Index

- Total number of people getting our daily forecast: 6,951
- Number of Beacon Checkers at trailheads: 8
- Number of field days last season: 112
- Number of snowpits we recorded in SnowPilot.org: 135
- Number of snowmobile a-arms broken by rocks in the first 100 miles of riding: 3



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- Highest wind gust reported: 104 mph on Lone Mtn. Summit, March 29.
- Number of times Doug was witnessed double-ejecting out of his skis: 1

Number of times unwitnessed: he's not saying

- Reported avalanches and incidents: 318 and 53
- Most number of skiers caught in a single avalanche: 3

The Friends of GNFAC:

- Taught 43 classes (62 days) to 3,136 total participants.
- 41 instructors taught Avalanche Awareness, Companion Rescue, and SAR group programs.
- All in-person classroom sessions went online.
- Field sessions were taught at a 1:4 ratio compared to a 1:6 ratio in years past.
- Offered extra field sessions to make up for smaller ratios.
- Built a video library for on-line content and outreach.
- School outreach packages included packets of stickers and brochures as well as access to our video library.
- Cooke City outreach be-



Skier triggered avalanche in Hyalite on January 9th, 2021. From those involved: "We dug a pit and found a really weak snowpack! Regardless, we proceeded to ski an East facing bowl, knowing that the slope angle was low and only flirted with 30°. My partner skied first, practically back to the skin track, when the slope failed and the entire bowl released." GNFAC forecasters measured the maximum slope angle in the start zone at 35° with an average slope angle of 33°. The avalanche broke on a layer of facets 1.5 feet above the ground, 2-3 feet deep, and propagated almost 1000 feet wide. ■ GNFAC

came more field based. Sessions were held every Saturday with snowpack updates and beacon training at Round Lake warming hut.

- Added a beacon park in Cooke City which saw a lot of traffic this year

—Alex Marienthal

HPAC

Overall the **Hatcher Pass Avalanche Center** had a very successful season with no avalanche fatalities and few injuries while a persistent, dangerous snowpack persisted through the entire season and produced historic avalanches.

Snow Report

The snow season for 2021 started late in Alaska. Most stations in the Alaska network started 2-3 weeks late. At Hatcher Pass the Independence Mine Snotel's snow-on date was October 15, about a week off of the normal October 8 start.

December 1 is NRCS's start date for monthly manual measurements. At that time Fishhook Basin's snow course was at 87% of normal.

Temperatures in Alaska started out above average and took a radical change at the end of January. This is easily seen in the graph of NOAA's temp departure from normal for Talkeetna.

This change also brought more snow for Hatcher Pass. Of note is the freezing drizzle event from February 26/27 which formed into a crust that would later become a significant and active PWL. In this weather event Independence Mine picked up ~5-6" of snow and an inch of SWE, with temperatures around 25°F. This should have been more than double the amount of snow. We estimate 0.5" of rain in this event.

Drizzle crusts have begun to be a more regular winter weather event at HP, with several drizzle events this season. All of these events have occurred when surface temperatures were well below freezing, at

right about 20°F. Drizzle crusts have become quite the topic of conversation since they pose a significant challenge to weather forecasting.

Kyle Van Peurse, Meteorologist at the Alaska-Pacific River Forecast Center and Avalanche Program Lead at the National Weather Service - Anchorage Forecast Office, has pointed out that there is no weather instrument or weather model for predicting this type of event. It is essentially a blind spot in weather forecasting. This season he reached out to a number of forecasters who have some experience with this phenomenon. Several theories and patterns have been identified which may help predict these events in the future.

Along with Drizzle Crusts, warmer weather has meant more rain and sun crusts forming and persisting in the snowpack. This season the combination of multiple drizzle and sun crusts became a major persistent weak layer problem.

March was a big snow month for Hatcher Pass. Since Independence Mine SNOTEL historical data is limited, we rely more heavily on historical snow course data, specifically Fishhook Basin which has the longest record of any of the Hatcher Pass locations. The gains made at the Fishhook Basin snow course were double March's historical normal for the month. The April 1 snow measurement was the only month that showed an above normal SWE in 2021.

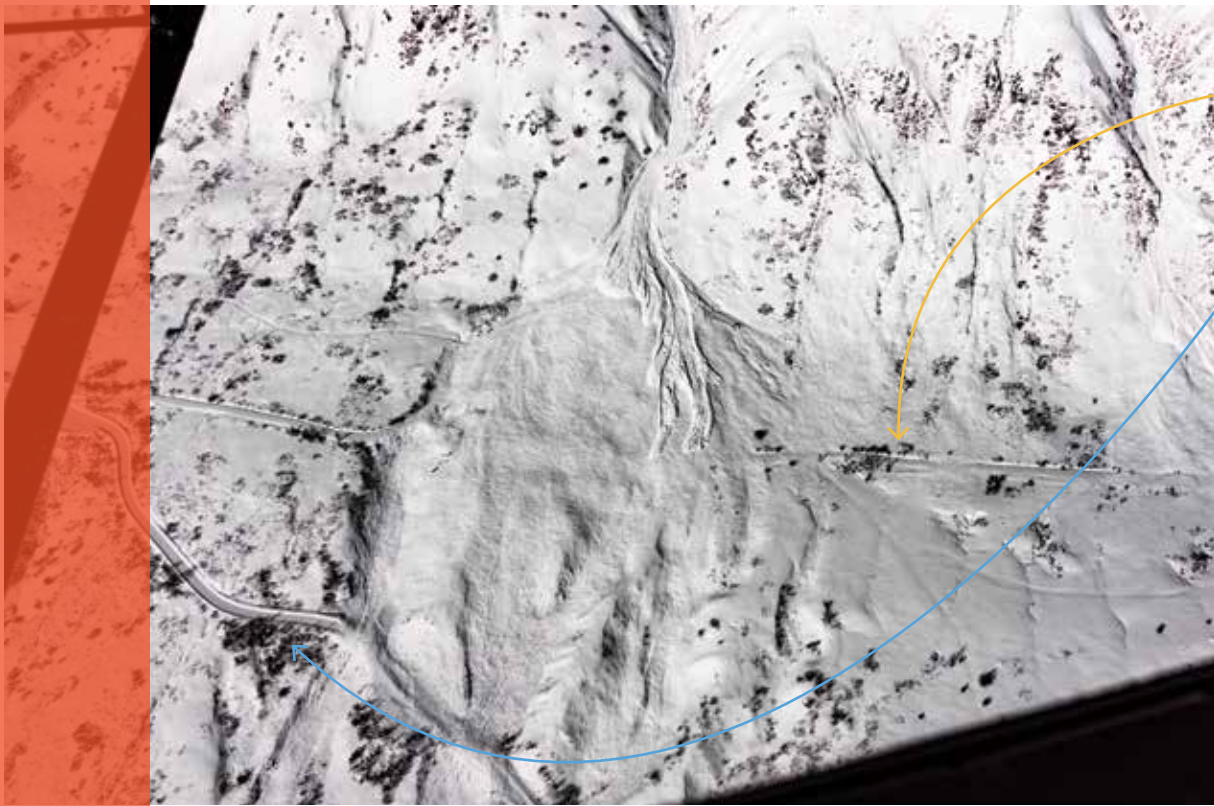
Cool temps through the first part of April preserved the low elevation snow pack. May 1 snow courses for Little Susitna (1700') and Archangel Road (2200') were more than 135% of normal.

Independence Mine SNOTEL's historical peak is April 28. This year

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Marmot Mountain natural avalanches crossing both the **Archangel winter cross-country trail** and **Fishhook-Willow Road**, the main winter access road to Hatcher Pass.

it peaked on April 25th. Meltout is normally May 31 and it was close to that date if not a tad early.

Snow for 2021 at Hatcher Pass was a gradual build, with a big March, peaking above average and mostly on time. Comparatively, Turnagain pass started with a bang and fizzled, although also peaking above average and mostly on time.

Avalanche Problems

A thin snowpack persisted through the end of February. Weak snowpack structure persisted with small to moderate loading events that easily tipped the balance. On a number of occasions, 4-6" of new low density snow produced natural activity up to D2 in size. Every month through this time period, human triggered avalanches occurred, with many remotely triggered avalanches. Persistent slab problems were present in 67% of our forecasts this season.

The combination of thin coverage and sensitive avalanche conditions put most backcountry travelers on guard. There was very little involvement in avalanches and no injuries or fatalities, but in many of these human triggered avalanches a large amount of luck kept people from becoming statistics.

One particularly scary persistent slab avalanche was triggered on Microdot on December 30, when a solo skier triggered a slab that propagated above him while attempting to position himself under a large rock feature as a safe zone. The avalanche overtook the safe zone and the skier was able to narrowly ski out of harm's way. The debris pile was nine feet deep, easily could have buried the skier, and the slope contained numerous exposed rocks which could have inflicted significant trauma.

A major shift in the snowpack changed at the end of February. A drizzle crust (FZDZ) was laid down on all aspects at all elevations. This crust became a widespread persistent weak layer. Small loading events continued to produce large avalanches on the widespread buried crust. Although the first part of the season was wrought with persistent slab issues, the snowpack had remained thin and very large avalanches did not occur. However, through March and into April, a significant amount of snow fell, increasing the depth of the avalanche problem, and increasing the danger and likelihood for larger avalanches.

Multiple crusts (very unusual) became problematic layers later in the season.

On March 25-26, approximately 10" of new snow accumulated at the upper elevations. A warning for natural activity and remotely triggered avalanche activity was stated in the conditions summary, but little natural avalanche activity occurred. On March 26 a group of backcountry travelers were ascending the normal skin track on Marmot Mountain. They observed no signs of natural activity and were also aware of persistent crust layers of concern. They remotely triggered two avalanches on their uptrack. One was small, the other was large and crossed and closed the Hatcher Pass road. The small avalanche was visible to the group on their tour. They were unaware of the larger avalanche until they were back at the road and other travelers informed them.

Numerous human triggered avalanches occurred between March 26 and April 3 on buried crusts. On April 3 a large storm threatened the area and the avalanche

hazard jumped to Considerable. The incoming storm was predicted to bring 18-24" of snow, but ended up delivering 11" of snow with 2" of SWE. An Avalanche Warning went into effect and high danger was issued the morning of Easter Sunday, lasting from April 4-5.

HPAC advised DOT and AK State Parks to close the road and trail corridors. As soon as the storm produced 0.1" of water per hour, five large to very large avalanche paths ran across the upper road and one of those crossed the lower road at the hairpin with numerous D3s and D3.5s reaching historic run outs. This cycle was estimated to be bigger than the infamous 1981 cycle. As a result of the five avalanches crossing and deeply burying the road, DOT kept the road closed for two weeks. HPAC continued to produce observations and forecasts from low and mid elevation below the road closure during this time.

Operations

A big change this year was the addition of a third paid assistant forecaster position, Jake Kayes, who worked as a paid observer last season. Jake produces the midweek conditions summary which encompasses most of a forecast minus the danger rating. Because HPAC produces one weekend forecast each week in addition to professional observations, this additional information has beefed up the product and kept the public more informed to weekly changes in conditions and avalanche hazards. This product is popular and is destined to morph into a full mid-week forecast in the future. Jake brings an enormous amount of knowledge and enthusiasm to study snow and avalanches,

bolstering the forecast team and the quality of our products.

Looking forward into the Covid crystal ball, the future was unsure. However, since we became our own non-profit, non-agency avy center, we've been on an exciting, positive adventure. HPAC had a record breaking fundraising season in 2020-21 and is set up well for the start of next season. We are looking forward to working again with Jake in 2021-22, purchasing a car with less than 200,000 miles on it for forecaster travel, as well as the 2022 Cabin Fever Reliever!

HPAC increased our avalanche awareness programs this year; we reached 300 users in 12 avalanche awareness program classes. Our social media presence continues to grow while offering quick, digestible forecast information to 3000+ users on Instagram and 8,500 users on Facebook, with the largest reach meeting 60,000 users in a single post this season.

Our board secured a number of grants this season for organizational development, educational outreach, avalanche information and warning signs, and the purchase of a drone. All fundraising efforts including grants, corporate donations, and personal donations increased this season, bolstering HPAC's ability to perform through products, programs, equipment, development and salaries for forecasters.

—Jed Workman and Allie Barker

IPAC

Whether you are a backcountry enthusiast or not, the **Idaho Panhandle Avalanche Center** thinks the storm to remember the 2020-2021 season by was the atmospheric river that made landfall in the area over January 12-13. We received heavy rains and warming temperatures up to the highest elevations and then the tail end of the storm brought extreme winds. Lower elevations, where the soils were saturated, saw massive devastation from trees uprooting and snapping. You can't talk to a person in our area who wasn't directly or indirectly affected by a tree hitting their house or vehicle. The higher country, where the snowpack helped to anchor trees, fared better,

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Forecasters Jeff Thompson and Eric Morgan checking out the crown from the avalanche on February 27th which claimed the life of one snowmobiler. Crown height was 120 cm. ■ MELISSA HENDRICKSON

but there were still quite a few riders that put in some hard labor to help clear the snowmobile trails. Cooler temperatures returned and we measured the rest of the season off this defining ice layer.

We received a dusting of snow on January 17 and then no more precipitation for almost two weeks. Cold temperatures and clear nights created near-surface and surface facets that had us all worried about how the rest of winter would play out. When snow accumulation started again in late January, it came in without wind, burying this weak layer intact on all aspects and elevations. Significant snowfall started the first week of February as we issued warnings for the 5th-7th. We all knew that this buried persistent weak layer was going to be causing problems for a while. That warning cycle was one of the touchiest we've seen in the IPAC areas: we were getting natural slides on 27° in the trees!

Coming out of the natural cycle, it was challenging as a forecaster to adequately convey the danger levels to our users. Our area isn't used to problems like this persisting through the winter along with problems that can be remotely triggered over a wide area. We upped our social media posting during this time with observations and posts of slides that users sent us to keep it fresh on people's radar. Users did well sticking to sub-avalanche terrain for a while, but when you have a considerable rating for over two weeks straight you start to see some of those F.A.C.E.T.S. working their way back into people's outings. We started having reports of human triggered avalanches nearly daily. As the persistent weak layer continued to get buried, the majority of these reports were from snowmobilers.

Then the unfortunate occurred, on Saturday, February 27th we received the report of a snowmobile fatality in the Silver Valley Forecasting area. This was the first backcountry

fatality in IPAC's forecasting zones since 2014. A group of three snowmobilers was caught, carried, and one fully buried. The avalanche was triggered from the toe of an open area at 28 to 30°, approximately 700ft below the crown of the avalanche. The crown height was 120cm and the avalanche slid on 5 – 10mm buried surface hoar resting above the Jan 12-13 rain crust.

By mid-March we felt comfortable enough with the depth of the buried weak layer to drop down to moderate then eventually low. But the question was always in the back of our forecasting minds if it was going to wake up again in the spring? Fortunately, we made it to an isothermal snowpack without having any more problems with this layer.

Among the season's accomplishments, we:

- Issued 39 biweekly forecasts and 19 general avalanche information updates. FoIPAC sponsored forecasting one day a week for two of our three zones, the rest of the forecasting was under the Forest Service umbrella. We are already seasoned pros at virtual communication; our forecasters are spread out over three different Forests, two different states, and two different time zones!
- Increased our efforts in recruiting observations by more social media outreach and running an observation contest for January and February. Our efforts paid off with 125 observations entered this season, up from only 23 last season!
- Produced over 50 field videos, regularly receiving around 2500 views per video. Our most popular videos were investigations of a near miss and the snowmobile fatality, receiving upwards of 7000 views each.
- Started a social media series called Backcountry Tips where

we posted short stories from forecasters, professional riders, and general backcountry users on their tips and tricks for traveling safely and comfortably in avalanche terrain. These were very popular with our users! Our favorites were that it takes two hill climbs to heat your burrito on your snowbike manifold and a detailed overview of a well-stocked tunnel bag from someone who had spent an unexpected night out.

- Partnered with our Friends group to teach more classes than ever. FoIPAC was able to run six Level 1 Avalanche Safety classes, including two motorized classes. We also conducted multiple avalanche awareness classes. Overall, we interacted with over 130 students in the field and over 1300 students through virtual classes! While

we are all tired of the virtual environment, we can't deny that we were able to reach more students than winter's past.

- Volunteers donated approximately 327 hours of field time towards IPAC operations, and FoIPAC board members contributed 470 hours to avalanche education, outreach, events, and fundraising.

The success of IPAC would not be possible without the dedication and support from the Friends of IPAC, our community, and our partners. Huge shout out to FoIPAC for keeping our existing snowmobile fleet running and helping us acquire two new ones this winter! From all of us at IPAC, thank you to everyone who contributed time or resources towards avalanche safety in Northern Idaho and NW Montana!

— Melissa Hendrickson ■



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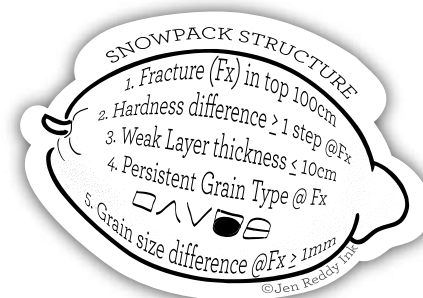
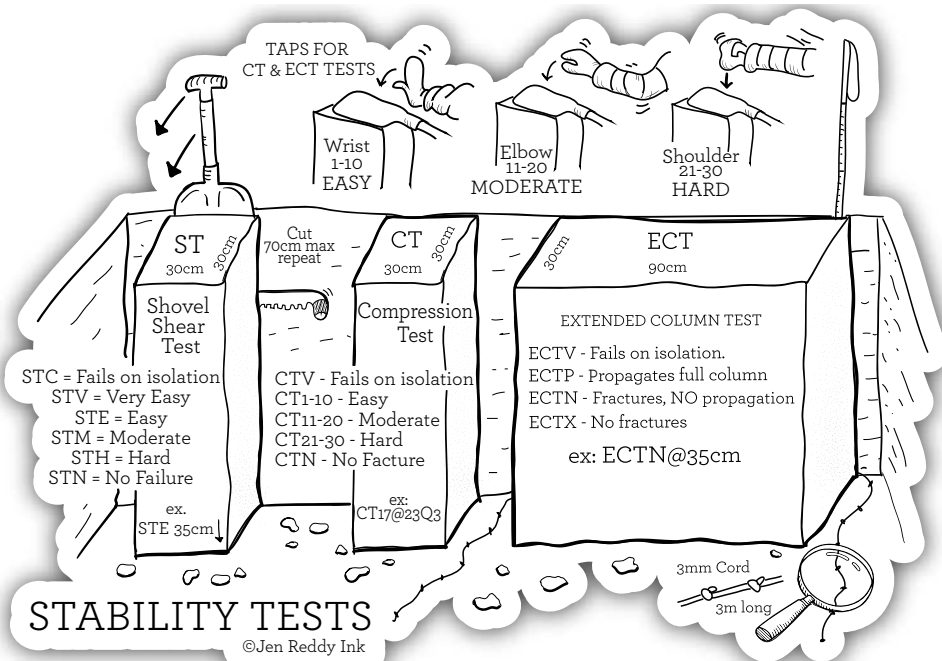
SNOW STICKERS

JEN REDDY

I was preparing to teach my first avalanche course of the season and my notes were filled with illustrations of the concepts I wanted to cover during the class. I stuffed the notes inside my pit book and spent the season referring back to these illustrations while teaching. All of these drawings merged themselves into the visual story of the Snow and Avalanche Basics poster (see page 53). Then, seeing the photocopied pages of the SWAG taped to the inside cover of a friend's pit book, I came up with the idea of turning my illustrations into a series of "cheat sheet" stickers that could be added to a pit book every year. To order visit www.jenreddyink.com.

Snow Crystal Classification

- + New Snow
 - / Decomposing
 - Rounds
 - Facets
 - ^ Depth Hoar
 - ✓ Surface Hoar
 - Melt Forms
 - Ice
 - ∇ Rime
 - = Rain Crust
 - Sun Crust
 - ⊙ Wind Pack
 - ⊗ Melt Freeze Crust
 - ⊗ Graupel
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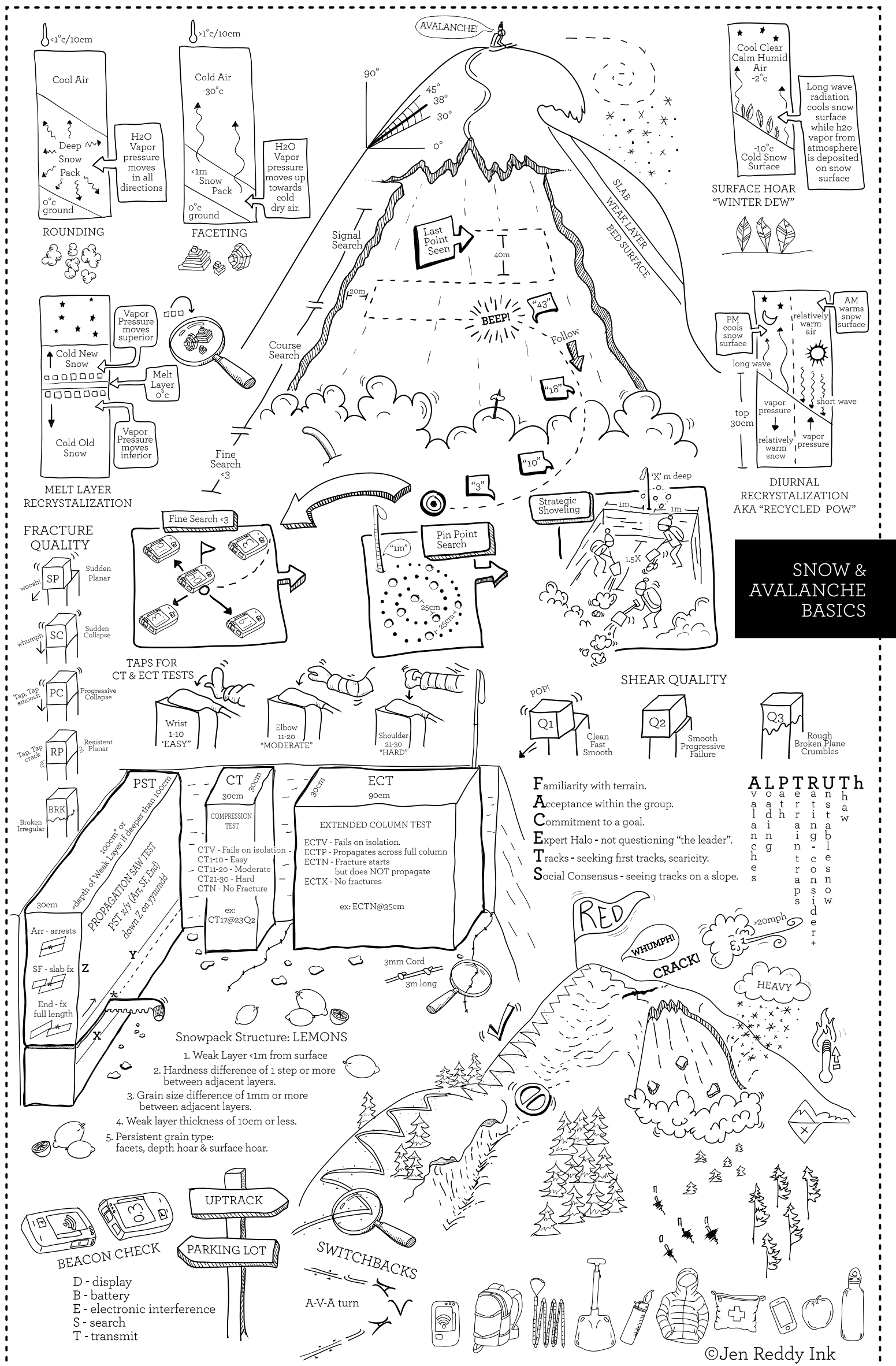


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AM warms snow surface

long wave

short wave

vapor pressure

relatively warm snow

top 30cm

SNOW & AVALANCHE BASICS

SHEAR QUALITY

Q1 Clean Fast Smooth

Q2 Smooth Progressive Failure

Q3 Rough Broken Plane Crumbles

Familiarity with terrain.
Acceptance within the group.
Commitment to a goal.
Expert Halo - not questioning "the leader".
Tracks - seeking first tracks, scarcity.
Social Consensus - seeing tracks on a slope.

ALP TRUTH

v o a e a n h
 a a t r r t t a
 d h a r t t a w
 l a i n g n t c o
 n g e s t r o s
 c h e s w e r s
 s e p s i d e r +

- Snowpack Structure: LEMONS**
1. Weak Layer <1m from surface
 2. Hardness difference of 1 step or more between adjacent layers.
 3. Grain size difference of 1mm or more between adjacent layers.
 4. Weak layer thickness of 10cm or less.
 5. Persistent grain type: facets, depth hoar & surface hoar.

BEACON CHECK

D - display
 B - battery
 E - electronic interference
 S - search
 T - transmit

DRONE CONTROL HAS ARRIVED



SENTINEL 6000

- Single Shot
- Muzzle Loaded
- Gravity Activated



DEAR A3 MEMBERS,

For the last three years, Maple Leaf Powder Company (MLP) has been working on the development of an explosives deployment system, via drone, for use in the North America avalanche control industries. This letter serves as an introduction and notification of the status of our product to date.

Over the years, we have found that the North American avalanche industries have struggled with worker safety issues, high prices, accuracy, reliability, and effectiveness in the products and systems available. Furthermore, the availability of an updated and modern system has been lacking for many years. MLP saw this gap in the marketplace and invested into the development of this new system called the Sentinel 6000.

MLP has secured patent pending status on the system and we have trialed it in many locations to confirm the effectiveness of the avalanche charges. We are now ready to engage with the industry to weigh specific interest in our product, to find additional onsite locations to trial the system and to look for potential partners to assist in the final phase of development.

Our goal in these trials is to demonstrate the improved safety, flexibility and effectiveness of the system over existing avalanche control options and to obtain one or more working sites that can be used as examples to the industry.

The system equipment consists of:

- large drone capable of carrying up to 6kg standard avalanche explosives payloads;
- radio control console with protection from the elements;
- landing gear apparatus ;
- deployment barrel complete with a trap door and two actuators;
- separate, dedicated radio control console with a magnetized antenna, redundant 2 mile communication;
- specially designed rounds that would be assembled onsite, using standard avalanche control explosives pyrotechnics, and Recco reflector chip;
- GPS locator for drone and charge accuracy;
- front facing video camera and a down facing video camera; and
- static electricity protection.

MLP has invested in the equipment needed to develop and demonstrate this system. It is available for demonstration purposes, in legal flying areas. The system is easily demonstrated without the need for any live explosives. Using our engineered drawings and a detailed procedures manual, MLP would like to show it to you at your earliest convenience. Please see pictures attached to this letter and reach out to give us your comments and feedback. We will be reaching out individually in the coming months also to canvas the industry.

Sentinel 6000 enhances worker safety, system accuracy, reliability, effectiveness along with greatly reduced costs. We are very excited about what we have developed to date and cannot wait to share our efforts with you. Thank you for your time and we very much look forward to hearing from you on this matter.

MAPLE LEAF POWDER COMPANY

David Sly, President

davidgsly@mapleleafpowder.com

250.661.3450

Maple Leaf Powder Company



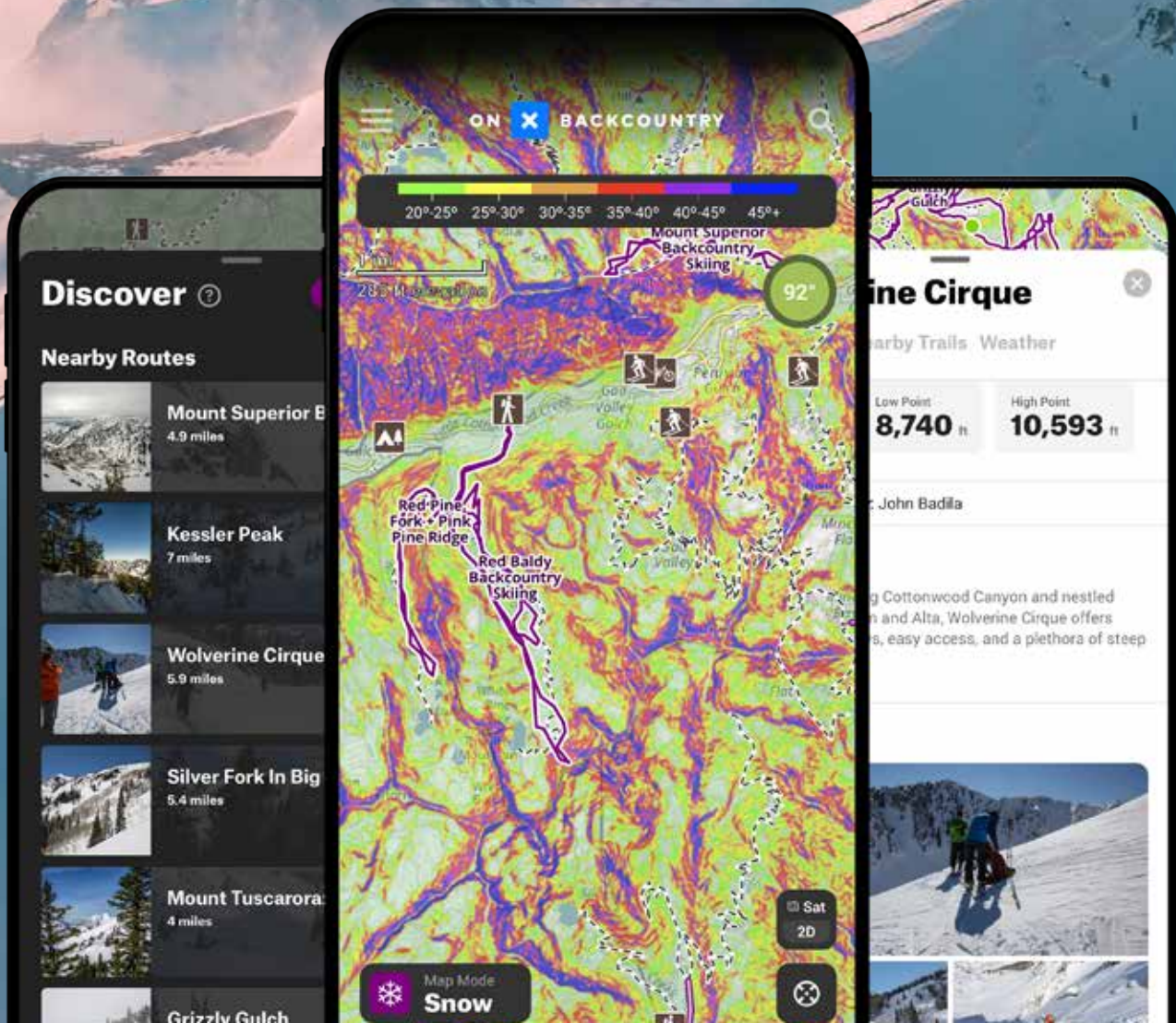
Sentinel 6000 drone and payload box

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**AMERICAN
AVALANCHE
ASSOCIATION**

MND SAFETY

safety@mnd.com / www.mnd.com

Your contact in North America

northamerica@mnd.com



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