

THE AVALANCHE REVIEW



EXTREMES
OUTLIERS
FUN FACTS

Mount Shasta: Andrew Kiefer climbs up along the crown of the Dec. 17th Casaval Ridge avalanche. Portions of the crown line were 6-7 feet deep. This avalanche completely obliterated the Lake Helen camp. Nobody was camped there fortunately. *Photo Nick Meyers*

THE AVALANCHE REVIEW

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

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AMERICAN
AVALANCHE
ASSOCIATION

AAA STATEMENT OF PURPOSE

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

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

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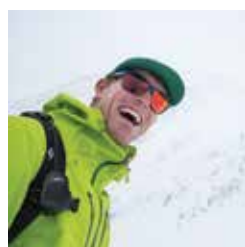
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Bruce Edgerly is co-founder and vice-president of Backcountry Access Inc. (BCA), a Colorado-based manufacturer of avalanche rescue equipment including Tracker transceivers, shovels, probes, snow study tools, BC Link radios, and its new MtnPro line of protective equipment for snowmobilers. BCA's mission is to save lives, not just sell product. The company backs its products up with consumer education and knowledgeable customer service.



Jeff Dobronyi is a ski guide and avalanche educator based in southwest Colorado. Between cold seasons, he can be found in Jackson guiding for Exum Mountain Guides, dreaming about deep winter storm cycles, and perfecting his margarita recipe.



Walter F. Ballenger (1925-1983) grew up near Chicago. After serving in WWII and attending University of Chicago, he went west to the California Bay Area where he wrote stories published in *Argosy*, *Prairie Schooner*, *Virginia Quarterly Review* and others. In 1960 he moved to the Sierra where he advanced from lift attendant to director of Squaw Valley's ski patrol and avalanche control.



Cy Whitting illustrates the soft snow and new singletrack he enjoys chasing in the Tetons. When he's not falling off things in the mountains or glued to his sketchbook, he swings a hammer to support his drawing habit. He enjoys bushwhacking and asking people if they know what Idaho's state gem is. More of his work can be found at cywhitting.com.

FROM THE EDITOR

BY LYNNE WOLFE

FIRE AND ICE BY ROBERT FROST

Some say the world will end in fire,
Some say in ice.
From what I've tasted of desire
I hold with those who favor fire.
But if it had to perish twice,
I think I know enough of hate
To say that for destruction ice
Is also great
And would suffice.

to keep our roads and ski areas safe, helping recreationists make wise decisions in uncertain environments.

In this issue, in addition to the Forest Service Avalanche Center season summaries, (and one dramatic non-FS summary from Andrew Hennigh at Mt. Rose) you'll find a timely piece on using snowmobiles for avalanche rescue from Bruce Edgerly and Mike Duffy, a long-awaited announcement that Scott Savage, Ethan Greene, and Bill Williamson's near-miss website is open for business, and two gripping "there I was..." stories. The first, a case study of a guiding day and decision-making process from Jeff Dobronyi, looks closely at margins with a custodial group in the notorious San Juans. The second is a historical piece from 1969 in the Sierra, with a winter that seems eerily familiar to this past one. We've split it into two parts due to size—look for part two in the December TAR.

The American Avalanche Association and *The Avalanche Review* send heartfelt thanks to each of you who woke before dawn for yet another control day, dug stuck sleds out of deep powder, or shoveled out the top shack one more time. We will continue to supply you with tools you need to make better decisions, to work together, and the clarity to understand new combinations of problems.

Our tentative themes for this upcoming volume are to the right, but not limited to these topics. What would you have us pursue? Who do you want to hear from? Please contact me with ideas and photos. ▲



September 2017. Idaho and Montana, it feels like the world is ending in fire. On our southern coasts, hurricanes and floods fill the news. In these pages you'll find stories from last winter's brigade of atmospheric rivers marching across the Pacific, bringing us extreme avalanche danger and many rain-on-snow events. In this initial issue of volume 36 of *The Avalanche Review*, Wendy Wagner and I asked our Forest Service Avalanche Centers to craft their season summaries around how they dealt with extremes, outliers, and fun facts. Even with more extreme ratings than ever issued, our fatality rates are flat. US avalanche professionals—forecasters, guides, patrollers—are working hard

TAR 36.2: Deadline October 1-15. Theme is "after the fire," tools to help avalanche rescuers, survivors, and victims with their recovery.

TAR 36.3: Deadline December 1-15. Theme revolves around wet snow and rain-on-snow.

TAR 36.4: Deadline February 1-15. This is the annual human factors, decision-making, and case studies issue.

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SNOW & AVALANCHE WORKSHOPS 2017/18 SEASON

BRECKENRIDGE, COLORADO

October 6, 2017

Colorado Snow & Avalanche Workshop
Riverwalk Center

BOZEMAN, MONTANA

October 11, 2017

MSU Snow & Avalanche Workshop

LAKE TAHOE, CALIFORNIA

October 14, 2017

California Avalanche Workshop
Lake Tahoe Community College, South

SEATTLE, WASHINGTON

October 22, 2017

Northwest Snow & Avalanche Workshop

JACKSON, WYOMING

October 28, 2017

Wyoming Snow & Avalanche Workshop
Center for the Arts

ANCHORAGE, ALASKA

November 3, 2017

Southcentral Alaska Avalanche Workshop
Alaska Pacific University
akavalancheworkshop.org

WHITEFISH, MONTANA

November 4, 2017

Northern Rockies Snow & Avalanche Workshop
www.flatheadavalanche.org/basic-page/northern-rockies-avalanche-safety-workshop

SNOWBIRD, UTAH

November 4 & 5, 2017

Utah Snow & Avalanche Workshop

FRYEBURG, MAINE

November 11, 2017

Eastern Snow & Avalanche Workshop
www.esaw.org

JUNEAU, ALASKA

December 9, 2017

Southeast Alaska Snow & Avalanche Workshop

KETCHUM, IDAHO

Spring 2018

Sawtooth Avalanche Center Professional Development Seminar

TRUCKEE, CA

Spring 2018

Sierra Avalanche Center Professional Development Workshop

BOZEMAN, MONTANA

Spring 2018

Gallatin Professional Development Seminar

FROM THE EXECUTIVE DIRECTOR

BY JAIME MUSNICKI

Greetings from the American Avalanche Association! This summer has been a busy one for us. We've been working hard on a number of projects - collaborating with course provider partners on final details to see the first new Pro Training courses offered this winter, redesigning avalanche.org in partnership with the National Avalanche Center, and creating internal organizational change to prepare the AAA for the path ahead.

A significant piece of this latter effort has focused on restructuring the Governing Board of the AAA. Through our recent membership survey and other avenues of communication we hear, loud and clear, that there is more the AAA can do "to promote and support professionalism and excellence in avalanche safety, education, and research in the United States." Over the last year and a half the Board has considered feedback, discussed strategic priorities, and identified specific steps to accomplish strategic goals. Among these steps, a nimble, engaged, and diverse Board is integral to moving the AAA forward to maximize impact of our mission.

To that end, the AAA Board invested two days this June to hash out details of a refreshed Board structure. Nearly all of the AAA's 23 current Board members participated in this work, either in-person, via conference call, or by proxy. An external nonprofit consultant facilitated a full day of discussion and decision-making around a new, ideal structure for the AAA Board, building on work that started at the AAA's spring 2016 Board meeting and had continued through the past year via committee and conference calls. The Board ulti-

mately voted to move forward with implementing the following (see figure for visual representation):

- 11-person Board (with flexibility in the future)
- At least 50% of Trustees elected
- AAA Professional membership strongly represented with at least five Trustee positions held by Pro members, including three of five Executive Committee members
- Opportunity to appoint or elect Trustees with more diverse skillsets (e.g. finance, marketing, publishing, etc.) to five different positions.
- Trustee term limits—a maximum of three consecutive two-year terms before required two years off the Board.

This new composition empowers the AAA to step strongly forward with a diversely skilled, committed Board at the helm to provide direction, vision, and action on strategy and goals for years to come.

As a final step of implementing these structural changes to the Board, the AAA needed to revise its bylaws. Bylaws are a written legal document that outlines the rules and guidelines for how a nonprofit organization, such as the AAA, will conduct itself; they are a requirement for incorporation (AAA was incorporated in the state of Utah in 1986) and provide a roadmap for the organization's actions. As the AAA is a membership-based organization, its bylaws were originally written to require membership approval of certain types of bylaw amendments, including those

changes that impact the voting rights of members. Thus, all members recently received an invitation to review and vote to approve (or not) the organization's newly amended bylaws.

The AAA worked closely with legal counsel in Utah on these bylaw changes. In addition to adjusting specifics related to Board structure, our lawyer also provided invaluable expertise in cleaning up and clarifying the language throughout the AAA bylaws. The amended bylaws are a refined, focused version of the prior document that strengthen the foundation upon which the AAA sits.

If you are a member and have not yet voted on the bylaw changes, we strongly encourage you to do so before the voting period closes on October 6th. If you have questions or want to discuss any aspects of the proposed changes to the Board, please do not hesitate to reach out to any AAA Board or Staff member. We are pleased with our progress to bolster the foundation of the AAA for sustained, positive impact on avalanche professionals and the industry well into the future.

What's going on with the AAA Pro Training Program?

We've been working hard this summer to make final preparations to launch the very first new Pro Training Courses this winter! The collaboration between the AAA, course providers, and other industry stakeholders to bring this program to fruition has been amazing. Here are a few key updates on the program as we head towards winter...

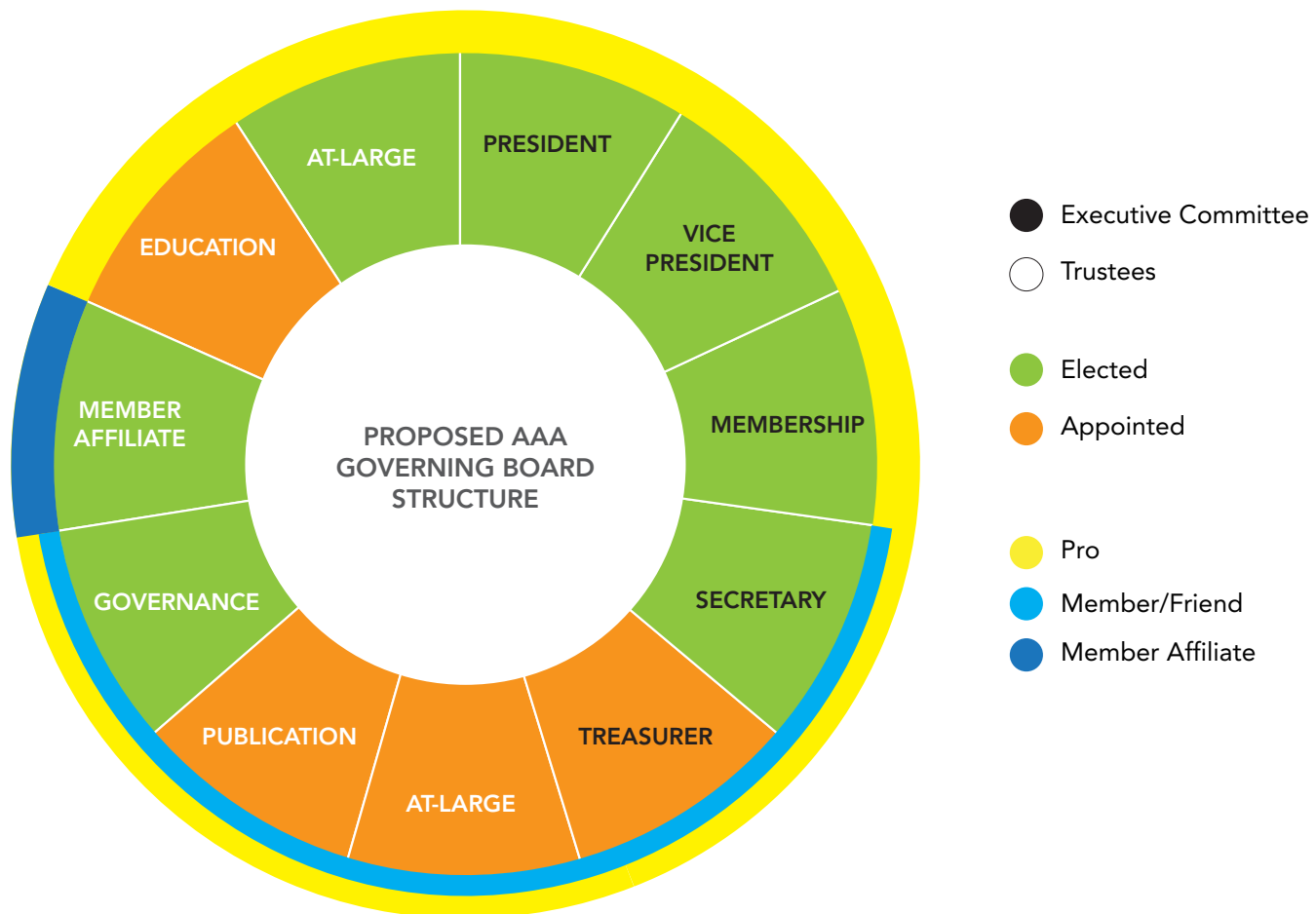


Figure 1: Proposed AAA Governing Board structure. Eleven voting trustees total, all AAA trustees are AAA members or friends, the term limit for appointed or elected positions is two-year terms with three consecutive terms allowed before two required years off.

CURRENT LEVEL OF TRAINING	EQUIVALENT WITHIN THE NEW PROFESSIONAL TRAINING SYSTEM	NEXT COURSE FOR PROFESSIONAL TRAINING
Level 1 Avalanche Training	Level 1 Avalanche Training	Avalanche Rescue Course (8 hrs) Pro 1 Course
Level 2 Avalanche Training	Pro 1 w/ completion of Bridge Course	Bridge Course For Pro 1 Certification Pro 1 Course
Level 3 Avalanche Training	Pro 2 Course	Continuing Professional Development
National Avalanche School (Classroom and Field prior to 2017)	Pro 1 w/ completion of Bridge Course	Bridge Course For Pro 1 Certification Pro 1 Course
National Avalanche School (Classroom and Field in 2017-18)	Pro 1-NAS Course	Pro 2 Course
AVPRO	Pro 2 Course	Continuing Professional Development

Table 1: A summary of the equivalence in the new Professional Training Program for professionals who have taken courses in the previous educational system.

Pro Course Providers

The following providers are proceeding through the rigorous review process as Pro Course Providers this season:

Alaska Avalanche School

www.alaskaavalancheschool.com



American Avalanche Institute

www.americanavalancheinstitute.com



American Institute for Avalanche Research and Education

avtraining.org



Colorado Mountain College Leadville

coloradomtn.edu/programs/avalanche-science



National Avalanche School

www.avalancheschool.org



Silverton Avalanche School

avyschool.com



These six organizations will be the only providers of Pro 1 and/or Pro 2 courses this winter. They have all been involved in developing and refining the AAA Pro Training program and courses in recent years. By starting with this limited and engaged cohort of providers, the AAA is invested in maintaining a high standard for professional course quality and consistency amongst providers within the program. This, along with collaboration and transparency, is a key tenant of the AAA Pro Training program. Contact these providers directly about pro course schedules and availability this season.

Pro Trainer Workshops

The AAA Pro Trainer Workshops provide Pro Course familiarization and training to current and future Pro Course instructors. Generally, individuals who attend one of these workshops already work for a Pro Course Provider and, frequently, have been recommended by that Provider to attend the workshop. The curriculum in these workshops focuses exclusively on pro course format, curriculum content, presentation techniques, and evaluation strategies.

This season's workshops will be as follows:

- **December 15-17, 2017**
hosted at Alta Ski Area in Alta, UT.
- **March/April 2018**
hosted at Mt. Rose outside Reno, NV, exact dates TBA fall 2017.

Consult with your anticipated Pro Course Provider employer about possible plans to work Pro Courses, then contact pro.training@avalanche.org with any additional questions and to obtain a Pro Trainer Workshop application. The initial application deadline is October 15th. Applications received after that date will be considered on a rolling basis after initial workshop enrollment decisions are made.

Recognized Equivalency

The AAA recognizes and values the experience and training of current avalanche professionals. We're all coming from the previous system where a LOT of variability exists in formal and informal training and professional paths. The AAA does not require or expect all avalanche professionals to pursue 'recognized equivalency' within the new system; however, we have defined a Prior Learning Assessment (PLA) process and table of recognized training equivalencies to help bridge between the old and new systems. We understand that 'recognized equivalency' may be a priority for certain pros for a variety of reasons (to meet Pro Course pre-requisites, apply for a new job, fulfill an employer's request, establish a clear place within the new system, etc.). Ultimately, the AAA seeks to be as inclusive as possible in applying these tools while still maintaining a level of consistency that supports the transition to the new system.

We anticipate most professionals will fall into one of the above (see Table 1) predefined categories referenced from our Prior Learning Assessment document.

Individuals who do not cleanly fit into one of these categories, and who believe they have equivalent training and experience can apply to the AAA for a PLA review if/as needed for pro course enrollment and/or to fulfill a requirement of employment. We are internally clarifying a few details of the process for gaining recognized equivalency as this issue of TAR goes to press. The AAA will email all members with more detailed information about pursuing recognized equivalency this fall. ▲



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THANK YOU!

Thank you to the Community Foundation of Teton Valley for hosting the 10th Annual Tin Cup Challenge, the Challengers for providing the matching grant funds, and everyone who generously gave to the American Avalanche Association through Tin Cup this summer. These contributions are matched by the Tin Cup Challenge fund, so they go even further to support AAA programs and initiatives!

Anonymous (1)	Dan Powers and
Kirk Bachman	Lynne Wolfe
Ned Bair	Graham Predeger
Miguel Browne and	Mark Renson
Silvija Strikis	Christian Santelices
Glenn Browning	and Sue Muncaster
Sam Colbeck	Uwe Sartori
Mike Ferrari	Scott Savage
Fitzgerald's Bicycles	Mike Schneider
Alfred and Eileen	Natalie Spencer
Fuchs Jr.	John Stimberis
Eric Geisler	Spencer Storm
Mark Guffey	Stuart Thompson
Jansen and Anna	Simon Trautman
Gunderson	Gene Urie
Ben Hammond and	Ryan Van Luit
Lisa Johnson	Knox Williams
Rob and Carol	Bill Williamson
Hoffman	Ben Winship and
Jake Hutchinson	Caroline Herter
Aleph Johnston-Bloom	Jim Woodmency
Trip Kinney	
Krister Kristensen	
Rob Landis	
Eeva Latosuo	
Evelyn Lees	
Jerry and Cindy	
Lucy	
Troy Marino	
Ian McCammon	
Halsted Morris	
Jaime Musnicki	
Erich Peitzsch	

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Andy Cook fixes one of the nearly 50,000 garments repaired at our Reno facility last year. TIM DAVIS © 2017 Patagonia, Inc.



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METAMORPHISM

CRESTED BUTTE AVALANCHE CENTER

We are excited to announce that **Ben Pritchett** was selected as our new executive director and lead forecaster. Ben brings a broad skillset and diverse experience in the avalanche industry to the CBAC. In the past 12 years, Ben has served as the program coordinator for AIARE and avalanche education coordinator for the CAIC, gaining valuable experience working with backcountry users, educators, and forecasters around the country. Ben is a former forecaster for the CBAC and leads the forecasting program for the Grand Traverse. He also owns and runs a backcountry guiding business here in Crested Butte. Ben's industry connections and local understanding of our terrain, weather, and snowpack will contribute to the quality of our forecast products. Ben will be replacing Zach Guy who is stepping down to be the director of the Flathead Avalanche Center in Montana.



UTAH AVALANCHE CENTER

The non-profit Utah Avalanche Center (UAC) is pleased to announce that **Chad Brackelsberg** has been named Executive Director. Chad brings more than 20 years of corporate experience in technology consulting and program/project management, has been a volunteer observer for the UAC for 8 years, and has worked with the local Utah outdoor community organizing ski mountaineering races for the past 10 years. Chad will replace former Executive Director Paul Diegel who has led the group since 2007 and will continue working with the UAC, focusing on educational projects.



The non-profit Utah Avalanche Center partners with the Forest Service Utah Avalanche Center to provide avalanche forecasting, awareness, and education statewide with offices in Salt Lake, Logan, Spring City, and Moab. The regular Forest Service forecasting staff, led by Director Mark Staples, will be returning for winter 2017-18.

NORTHWEST AVALANCHE CENTER

Garth Ferber retires.

From Garth's desk: It began with the purchase of wood skis, cable bindings, leather lace boots and bamboo ski poles at the Goodwill in the 1960s and learning to ski with my family at The Mountaineer's Snoqualmie Pass and Meany Lodges. I fortunately chose Atmospheric Science as a major at the University of Washington in the 1980s, which led to a job at the National Weather Service in Seattle, while learning about backcountry skiing and avalanches. This in turn led to a job across the aisle at the Northwest Avalanche Center for which I especially want to thank Larry Donovan, Mark Moore, and Kenny Kramer. I'll retire at the end of 2017 after 30 years of federal service. You may not have seen or heard the last of me since we are discussing the possibility of my help with NWAC weather station maintenance, on a contract basis, post-retirement. I am very grateful for friendship, communication, humor, collaboration with many great people in the avalanche industry during my career at the NWAC.



Welcome to Robert Hahn!

Robert Hahn grew up at sea-level in the Boston area but gravitated to the mountains for hiking, rock-climbing, and skiing. These experiences instilled in him a strong respect for earth's ecosystems and a fascination for the weather which helped create them. Robert studied geosciences at Williams College, located in the Berkshire Mountains of western MA, and spent his freshman summer ski touring across the Juneau Icefield as part of a glaciology research program. His graduate studies in Atmospheric Sciences at the University of Washington led to published research involving forecasting of mountain precipitation using modified high resolution computer models. He subsequently worked in the private sector doing environmental consulting before serving for two years as a literacy volunteer in the Peace Corps at two primary schools in rural southwestern Uganda. During Seattle's warmer months Robert has been drawn back to Uganda to conduct workshops for children and teachers on literacy as well as social and environmental issues. Robert's passion for skiing and mountaineering continues locally and internationally. He has skied 300+ days in Washington and British Columbia backcountry since 2005 and he has summited glaciated peaks on five continents, including hiking the Great Himalayan Trail in Nepal. Robert joined NWAC in May 2017. He looks forward to connecting with the snowpack from the forecasting office and the slopes, and enthusiastically supports NWAC's mission of improving safety for all mountain travelers. ▲



NEW ADDITIONS TO THE AAA MEMORIAL LIST

BY HALSTED MORRIS,
VICE PRESIDENT AND CHAIR OF THE AWARDS AND
MEMORIAL LIST COMMITTEE

Sadly, this past spring the AAA governing board voted to add two additional persons to the AAA memorial list. This brings the memorial list to a total of 72 persons. One of the new additions was actually killed in 2006. Her death was brought to my attention, and falls within the memorial list criteria. The two new additions are:

February 02, 2006

Johanna Carlsson, 31, off-duty professional Mammoth ski patroller, killed in a backcountry avalanche outside of Bridgeport, CA.

January 24, 2017

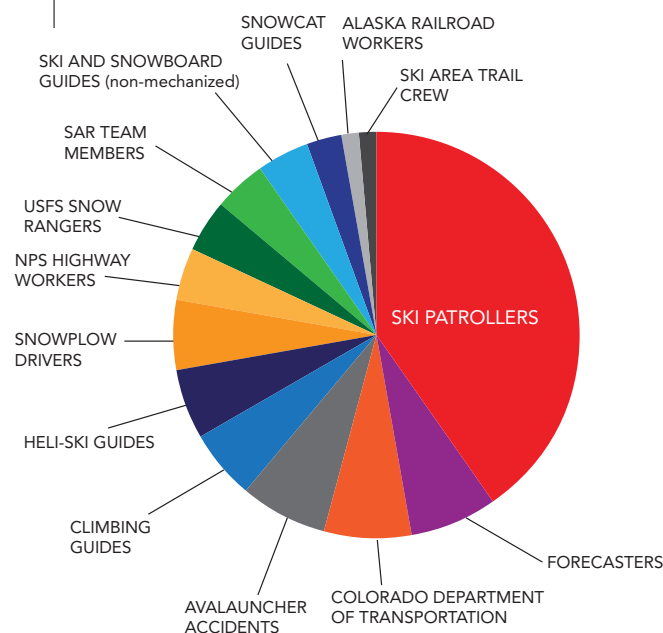
Joe Zuiches, 42, professional ski patroller at Squaw Valley, killed in an explosive accident while doing control work.

Of the 72 listed persons on the memorial list, 29 are ski patrollers, 5 forecasters, 5 Colorado Dept. of Transportation workers, 5 in avalanche accidents, 4 climbing guides, 4 heliski guides, 3 National Park Service highway workers, 3 USFS Snow Rangers, 3 Search and Rescue team members, 2 snowcat skiing guides, 2 ski guides (non-mechanized), 2 California County Snowplow drivers, 1 snowboard guide (non-mechanized), 1 Alaska snowplow driver, 1 Colorado County snowplow driver, 1 Alaska Railroad worker and 1 ski area trail crew member.

On behalf of the American Avalanche Association, we wish to offer our sincere condolences to Johanna and Joe's families, coworkers and friends. The memorial list exists to not only remember fellow snow and avalanche workers, but as a reminder of the dangers involved with the snow and avalanche industry.

The AAA Memorial List will be updated on the website later this fall. ▲

OCCUPATIONS OF PERSONS ON THE MEMORIAL LIST





A fourteen-day storm cycle around Cooke City this past winter produced amazing powder riding. Photo Eric Knoff

THE AVALANCHE HOUR *podcast*

BY CALEB MERRILL

The idea for The Avalanche Hour Podcast came about while driving to the International Snow Science Workshop last fall. I had been listening to podcasts throughout the long drive from the Cascades to Breckenridge, and was looking to dust off my snow brain from a long summer of fighting wildland fires. I was surprised upon typing Avalanche into the podcast search bar to find results only related to the Colorado Avalanche NHL team. I thought that somebody must be producing a podcast related to avalanches and snow science, but my inquiries throughout the conference and beyond yielded no results.

So the process began of researching how to create a podcast. The Internet provided an overwhelming amount of information and opinions on ways to record, edit, produce, and publish podcasts. An Indiegogo campaign was launched to gain support, create some social media buzz, and purchase some necessary equipment. The goal of The Avalanche Hour Podcast became to create a stronger community through the sharing of stories, knowledge, and news amongst people who have a curious fascination with avalanches. The plan was to present stories of lessons learned through near misses as well as interviews with prominent avalanche professionals. Through feedback from listeners, I hope to create a product that will continue to be entertaining, educational, and compelling to listen to. Ultimately, I hope that the podcast will evolve with the help and input of the avalanche community at large.

After releasing some teaser short episodes throughout January, the first full length episode hit the airwaves in the middle of February. I produced five episodes throughout the winter months of 2017. During that time, my recording, editing, and producing skills improved. The spring, summer, and fall months at The Avalanche Hour Headquarters have been spent gathering content and interviews with the hope of having some cached episodes to roll out during the busy winter season. Our fundraising manager was able to secure the support from two great companies for the upcoming winter season. TAS-Gazex and Black Diamond have both come up big with financial support to help purchase better recording equipment, attend trainings, and cover travel expenses to conduct better quality in person interviews. The goal for the upcoming winter is to produce two podcasts a month from October through April.

Check out the website www.theavalanchehour.com to find links to our shows on iTunes and Soundcloud, bios of our guests, and even an online store to order some free stickers or purchase your Avalanche Hour Podcast swag (which helps to support the show!). Head on over to iTunes to rate and review the show. If you would like to be a guest on the show, have a compelling story to tell, or just want to send me some feedback, please email me at theavalanchehourpodcast@gmail.com. Join the conversation! ▲




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CNFAIC INTERNSHIP UPDATE

Thanks to Conrad Chapman

BY ALEPH JOHNSTON-BLOOM

The CNFAIC internship for the 2017 season finished up the final week of March. Conrad Chapman, this season's intern, came in with enthusiasm and curiosity and became an integral part of the team. Conrad is a born and raised Alaskan who became interested in snow through enjoying snow activities but also by being excited by science and understanding natural processes. He was part of the recently formed grassroots Eastern Alaska Range Avalanche Center (ERAC) based in Fairbanks and pursued the CNFAIC internship in order to get more exposure to professional forecasting and to see a different Alaskan snow climate. He took a semester off from the University of Alaska, Fairbanks, to participate in the internship.

Conrad's internship project and focus were on developing his observation and writing skills in order to be able to produce the Saturday Summit Summary on his own. The forecasters each worked with him in the field sharing their personal methods for targeting observations and developing focused questions. Conrad then refined his attention to detail, snow pit craftsmanship, snowpack assessment, and photography skills in order to clearly communicate his thoughts on stability. It was a pleasure to see him improve over the season and to see how much he appreciated the experience. Conrad successfully wrote the Summit Summary throughout the month of March.

Conrad was exposed to the diverse Girdwood snow and avalanche community through participating in the CNFAIC-hosted weekly stability meetings with AK DOT, CPG, and the Alaska Avalanche School. He also shadowed an Alaska Avalanche School Level 1 class, observed an AK DOT/AKRR avalanche hazard reduction mission in the Seward Highway corridor, helped teach rescue workshops at Hatcher Pass and Turnagain Pass and sat in on a Chugach Powder Guides morning meeting.

Conrad improved his snowmachine skills and backcountry skiing skills. He pitched in helping plow the Glacier Ranger District parking lots and helped with snowmachine maintenance. He had a positive attitude and was a solid field partner.

In our final debrief he stated that his main internship take-aways were, "Having an organization system that works for me, i.e. writing stuff down, the importance of having a plan/ focused questions for the day, the importance of a routine for what I check, when I check, and why I check, being more precise in what I am saying and how I am saying things, recognizing the time commitment of the job, forecasting is much more of a lifestyle, appreciating the time spent on sleds and how travel and looking at snow is different and similar to skiing."

Conrad is looking forward to finishing his undergraduate degree at UAF, continuing to build ERAC and pursuing the next steps in his snow and avalanche career. At this point he is looking at becoming ski patroller and maybe even venturing down to experience winter the lower 48. We thoroughly enjoyed having him and wish him luck in his future endeavors.

From Conrad: This past spring season I got the opportunity to intern with the Chugach National Forest Avalanche Information Center (CNFAIC). For me this internship was jumping into the deep end of the world of avalanche forecasting. This gave me the opportunity to observe and participate in a team that is putting out daily avalanche advisories. Being able to devote the 2017 season solely to this internship was a great decision.

For me, a big take away from this internship was that avalanche forecasting is more a lifestyle than a job. To live and breathe avalanches, weather data, and public observations for half of the year takes an impressive amount of mental organization and passion for snow science. Being given real responsibility as well as the chance to write about conditions and get feedback almost daily really pushed me to use and grow my understanding of snow science. I think the most important part of this feedback system was seeing where my skills were at and learning what I needed to work on and then being able to feel my comfort and competence grow.

For anyone who is looking to participate in an internship like this I would highly recommend devoting a season to the internship. In addition to this it was helpful to ask lots of questions and be open to any feedback that the forecasting team has to offer. Being able to devote all my time to this internship as well as being open to the feedback I received really allowed me to get the most out of my brief time with the crew at the CNFAIC and gave me new goals to work towards. I would wholeheartedly recommend an internship like this to anyone interested in the field of snow science and avalanche forecasting, this was truly a life changing opportunity. ▲

Aleph Johnston-Bloom is an avalanche specialist for the Chugach National Forest Avalanche Information Center in Girdwood. Starting her fifth winter in Alaska, she is thinking cold thoughts and really hopes there is snow to sea level. She is the former director of both the Silverton Avalanche School and the Alaska Avalanche School. She is an American Avalanche Association Certified Instructor, Professional Member and the Secretary of the A3 Governing Board. Over the past 17 years she has garnered experience as a highway avalanche forecaster, a backcountry avalanche forecaster, a patroller and a ski guide.



Conrad hard at work checking out layers.
Photo Heather Thamm

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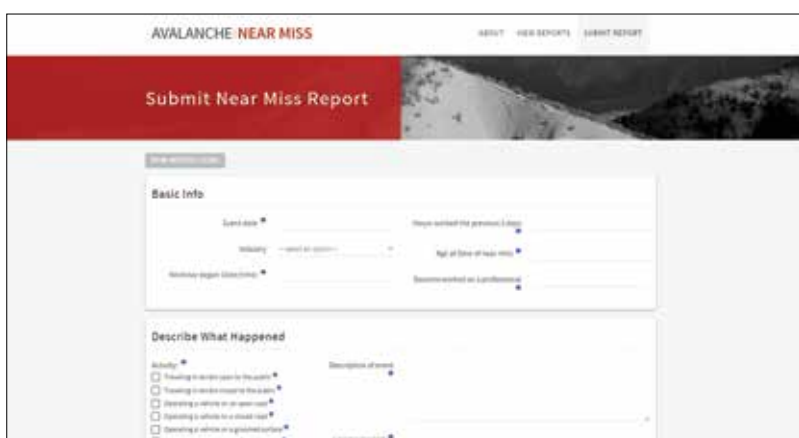


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AVALANCHENEARMISS.ORG

The Professional Near Miss Database is Live!

BY SCOTT SAVAGE, ETHAN GREENE, AND BILL WILLIAMSON
AVALANCHE WORKER SAFETY



Avalanche accidents are often well documented by public sector investigators and published in volumes like *The Snowy Torrents* or *Avalanche Accidents in Canada*. The lessons learned from these reports are invaluable. Working with avalanches requires a wealth of experience, and a seasoned avalanche worker's most valuable experiences often come from events that don't end in injury or death—from near misses. Avalanchenearmiss.org is a place for avalanche workers to tell their stories, share their experiences, and learn from each other.

This project is patterned after a similar effort in the Firefighter and Law Enforcement communities. Nationalnearmiss.org has run successful near miss data collection and dissemination efforts in these communities for many years. Avalanchenearmiss.org is based on their work and built with their guidance. The database and submission form are designed to collect enough information to help others understand the near miss, help institutions and researchers look for trends, and make it as easy as possible for people to submit a report.

Avalanchenearmiss.org collects information on workplace near misses and accidents involving avalanche workers. Each submission is reviewed by a volunteer moderator. The moderator will remove any information that identifies the people, organization, or location involved in the incident, ensuring the published reports are completely anonymous. Reviewed reports are available for anyone to read—no subscriptions are needed. Basic search functions and filters exist to help you quickly find pertinent reports, and more advanced report viewing tools are already planned.

Avalanchenearmiss.org is a project of Avalanche Worker Safety (AWS), a 501(c)3 not-for-profit group that seeks to increase the level of safety in snow and avalanche operations by forming partnerships and providing pathways to share information. AWS views the near miss database as an essential first step in a broad campaign to improve avalanche worker safety.

We need your help! Please submit your stories. This project will be as good as you—the professional avalanche community—make it. The ultimate goal: other avalanche workers can learn from your near misses or incidents and you can learn from theirs.

Frequently Asked Questions:

Where do I go to tell my stories or to learn more about this project?
www.avalanchenearmiss.org

Can I enter close calls or near misses that don't involve avalanches?
Yes, the platform is setup to accept any workplace near miss (e.g. transportation, aviation, etc)

Can I enter accidents that happened years ago?
Yes, we hope that people will submit experiences from throughout their careers. The more reports the better.

What if I don't know the date a near miss occurred?

Guess. Inaccurate dates will not affect this project. If you're missing a few specific details (date, weather, snowfall amounts, etc), don't sweat it—tell us what you do remember. We want your stories and what you learned.

I'm worried I'll get in trouble at work for submitting events—will I?

Please don't participate without first getting the OK from your operation or supervisor. We don't want to get you in trouble! Many operations are thrilled to participate, but some may choose not to take advantage of this resource. We'll keep working to address their concerns. ▲

PRO DEVELOPMENT WORKSHOP 2017: BOZEMAN, MONTANA

BY ERIC KNOFF

The 2017 Pro Development Workshop in Bozeman, MT had roughly 50 attendees and was held at the Bozeman Public Library on March 29. Contrary to previous years, the 2017 workshop did not have a specific topic of discussion. Instead, it covered a variety of topics presented by ten different speakers. It was once again filmed in high definition and put on Youtube for public view.

The day kicked off with Jamie Yount, lead forecaster for Wyoming DOT, explaining the challenges of forecasting and controlling four different public corridors around Jackson Hole, WY. The talk started with Jamie giving an overview of the roads affected by avalanches. Jamie then discussed two specific weather events that produced significant avalanche activity throughout the WDOT forecast area. The most significant event was the "Power Line Event" which affected the area from February 1st to February 10th. During this period, WDOT reported 40 avalanches that hit public roads, Teton Pass was closed for an unprecedented four days in a row and the governor of Wyoming declared a state of emergency. By the end of the winter, over 500" of snow fell, resulting in 68 avalanches hitting roads across the forecast area. The WDOT forecasters shot the Gasex a total of 52 times and ObellX 13 times. There were a few closes calls on the road, but overall it was a job well done avoiding large scale avalanche incidents.

The second speaker was Kevin Hammonds, a researcher and professor at Montana State University. Kevin's talk, Investigating the Thermophysical Properties of the Ice-Snow Interface, described the how ice crusts or vapor barriers within the snowpack can develop large temperature gradients on a microscopic scale along the snow ice interface. These temperature gradients are nearly impossible to measure in the field, but have proven to be a contributing factor to facet growth in the lab. Kevin's research found that large temperature gradients developed both above and below the crust, however, the bottom of the crust had a much larger gradient than the top. Thermal contact resistance was found to be the largest contributing mechanism to increased temperature gradients. This talk was scientific, but presented relevant information to backcountry practitioners.

Tony Lebaron, MSU PHD student, provided a look at the microstructure-based modeling of energy release in snow. Tony's research models how much energy it takes to break individual bonds between ice grains, which can then be applied to larger scale models. Tony found that, when a weak layer is present, fracture energy is more directed along the weakness

and fracture speeds increase. If no weak layer is present, the breaks between bonds are spatially random. Tony commented that weak layer fracture and avalanche release may be a more diffuse process than originally thought. Tony closed his talk by raising the question—Does avalanche mitigation with explosives lead to post control release by applying damage to buried weak layers? This question was received with mixed reviews and generated good conversation.

Evelyn Lees, forecaster for the Utah Avalanche Center (UAC), gave an informative and witty talk about 25 years of avalanche forecasting. Evelyn began by discussing the evolution of forecasting from the early days of listening to the forecast on the phone, to the challenges of modern day social media. She then described a near miss with the emphasis on how we're all susceptible to making and repeating mistakes. This was followed up by Evelyn describing the importance of having a good routine, good partners, and communicating clearly. The talk was wrapped up with conversation on the challenges of a rapidly growing user group combined with a constantly changing avalanche industry. A take home message from this talk was that communication needs to be more open and clear between forecast centers, ski areas, guide companies, highway operations and backcountry recreationalists in order to generate the most informative avalanche information possible.

Zach Guy, director of the Crested Butte Avalanche Center and now the new director of the Flathead Avalanche Center in NW Montana, gave an engaging talk about forecasting EXTREME avalanche events. Zach mentioned early in his talk how the use of the EXTREME danger rating generated a very high interest with the local media, resulting in a full day of phone conversations. Zach then posed the question – how do you define HIGH vs EXTREME avalanche danger. He followed this question by describing a personal set of criteria which involved widespread D3s and D4s reaching the valley floor. The talk was concluded by Zach presenting two different weather events that resulted in the use of the EXTREME rating. Both events had very high SWE totals ranging from 12" to 14" over a two-week period.

Erich Peitzsch, former director of the Flathead Avalanche Center and current PHD student at MSU, talked about losing a local legend and close friend in an avalanche accident in Glacier National Park. This skier was experienced and educated in avalanche safety and backcountry travel. This

talk raised questions on what it means to be experienced both professionally and personally. It was concluded that experience can be a double-edged sword by keeping us safe in the mountains but also tricking us into thinking we know more than we actually do. The talk was wrapped up by Erich's emphasis on the importance of communication and data collection to facilitate better decision-making when uncertainty is high.

Chris Bilbrey, graduate student in snow science at MSU, discussed the effect of slope-scale spatial variability of slab characteristics on PST cut lengths. Chris mentioned that most PST research has been done on uniform slopes. Chris's research describes how variable slab characteristics affect PST critical cut lengths and crack propagation. Chris conducted 195 PSTs, 49 ECTs and 65 CTs during 13 field days. Slab depth, density, and H₂O content were collected for each data set. Chris's talk emphasized the important role the slab plays in crack propagation and avalanche release.

John Sykes, graduate student at MSU, did a talk titled Human factors in lift-accessed backcountry terrain. John's research focused on Saddle Peak, a sidecountry destination outside of Bridger Bowl. The study was conducted by issuing skiers a GPS unit as they headed out of bounds at the ski area boundary. Each skier also filled out a short questionnaire. The GPS units were collected and tracks were downloaded onto a DEM (digital elevation model) of Saddle Peak. Data collected on Saddle Peak was then combined with avalanche danger rating for that day with the primary avalanche problem. This study was designed to assess how individuals make decisions in lift-accessed backcountry terrain.

The ninth speaker of the day was Karl Birkeland, whose talk was titled Temporal changes in PST cut lengths following loading. Karl's research investigates the difference in PST critical cut lengths when an additional load is added to an existing slab/weak layer combination. Field work was conducted by constructing slabs of various thicknesses, which added load to an existing slab/weak layer combination. Slabs were built with the same dimensions as a PST, which were isolated and cut at different time intervals, often resulting in different cut lengths. Cut lengths were shortest when done within 30 minutes of the loading event, but got progressively longer as time went on. Karl attributed increased cut lengths over time to a combination of slab stiffening and weak layer strengthening. This talk presented a clear example of why avalanches are likely during or immediately after a loading event.

The final speaker of the day was Alex Marienthal, avalanche forecaster for the Gallatin National Forest Avalanche Center. While most attendees were thinking about pitchers of beer, Alex did his best keeping the crowd engaged by discussing an historic avalanche cycle and EXTREME danger around Cooke City. After Zach Guy's recount of his extreme struggles with Extreme danger in Crested Butte, Alex showcased the flawless forecasting at the GNFAAC during the Extreme danger in Cooke City.

Once the lectures were complete, the workshop quickly moved from the library to Montana Ale Works, where an informal yet effective style of learning ensured. Overall, the 2017 Pro Development Workshop in Bozeman, MT proved to be worthwhile and informative. ▲



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19TH EUROPEAN AVALANCHE WARNING SERVICE CONFERENCE

BY ETHAN GREENE

National avalanche warning services of European countries have been meeting since 1983 as a unified group known as the European Avalanche Warning Service (EAWS). The EAWS was formed to exchange ideas and operational procedures, develop standards, share rules and regulations, develop common elements in forecast products, and improve the efficiency and skill of avalanche forecasting groups. The group meets as a whole every two years and forms working groups to address specific topics and projects. Participants from North America have attended these meetings in the past, with Avalanche Canada having the most consistent presence. The 19th meeting of the EAWS was held June 12-15, 2017 in Tutzing, Germany and below is a summary of the conference.

As with any good meeting, the events started with a pre-meeting. The Swedish Environmental Protection Agency (SEPA) hosted a workshop on Developing Standards to Measure Success of Avalanche Safety Programs. Representatives from Sweden, Norway, Germany, Canada, and the United States attended. SEPA staff led the group through a variety of exercises and discussions on previous work, needs for reporting, and critical factors that should be included in performance metrics. By the end of the day the participants identified six areas for continued work: 1) develop a common method to estimate the number of users, 2) develop standards for measuring and reporting contact with users (e.g. web statistics), 3) develop methods for estimating incident rates, 4) develop resources for groups to obtain information through user surveys, 5) develop resources to evaluate education programs, 6) investigate user value and potential funding sources.

The EAWS meeting was held at the Evangelische Akademie Tutzing. The academy was founded in 1947 by the Evangelical Lutheran Church as a venue for conferences, seminars, and scientific colloquia. It is an idyllic setting with grounds that include the Tutziger castle (originally completed in 1816) and a large garden (built in 1840) that abuts the shore of Lake Starnberg. The meeting felt a little like being at the United Nations with a row of translators in sound proof cubicles and a room full of participants wearing headsets. The EAWS meeting began in the evening with a social event hosted by the Bavarian State Ministry of Environment.

The first day of the meeting was dedicated to the business of the organization. The group formally adopted a Memo of Understanding between all of the members. This document outlines the purpose of the group, membership, governance, technical advisory boards and



No avalanche meeting is complete without beer. The SEPA pre-meeting discussed a number of performance metrics for measuring success of avalanche safety programs.
Photo courtesy Ethan Greene





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working groups, and standards. Each member country is allocated 84 votes and can distribute them between avalanche warning services in that country as they see fit. The member countries (Andorra, Austria, Czech Republic, Finland, France, Germany, United Kingdom, Iceland, Italy, Norway, Poland, Romania, Slovenia, Slovakia, Spain, Switzerland) ratified the agreement.

The second order of business was to review and vote on a schema of avalanche problems for public communication. A working group presented an overview of their effort including the purpose of the proposed system and its utility in public bulletins. The schema has five categories with a What, Where, Why, When, and How to Manage section, color icon, and black/white icon for each one. The categories are: New snow, Wind-drifted snow, Persistent weak layers, Wet snow, and Gliding snow. The North American contingent made a formal request that EAWS members use a term other than Avalanche Problem for the English translations of their products. The argument was the system being considered was based primarily on the physical and meteorological properties of the snow and avalanche formation. This is fundamentally dif-



The Tutziger castle (originally completed in 1816) and a large garden (built in 1840) that abuts the shore of Lake Starnberg were idyllic grounds for holding an avalanche meeting. All photos courtesy Ethan Greene

THE MEETING FELT A LITTLE LIKE BEING AT THE UNITED NATIONS WITH A ROW OF TRANSLATORS IN SOUND PROOF CUBICLES AND A ROOM FULL OF PARTICIPANTS WEARING HEADSETS.

ferent from the system widely used in North America, where the Avalanche Problem is comprised of avalanche size, likelihood of triggering, location and a category based primarily on risk treatment. The intent was not to debate the merits of each approach, but to acknowledge they are different and mitigate the risk of users from various regions, confusing the public safety message. After a brief discussion the document was ratified by the members without change.

The next proposal was to change the term that describes each category in the avalanche size scale. The scale used in Europe is similar to the Avalanche Size scale in OGRS and the Size-Destructive Force in SWAG. Currently the European scale uses the terms sluff, small, medium, large, very large to describe categories 1 through 5. The justification for the change focused on the small (size 2) and very large (size 5) categories. The concern was that these terms were not



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effectively communicating the avalanche size to the users of recreational bulletins. Recreationalists often describe size 2 avalanches as large (or very large). Warning about small events in the bulletin increased the chance that people would misinterpret the message. Similarly most recreationalists referred to size 3 or 4 avalanches as very large. When the bulletin warns of very large avalanches it is describing avalanches that will destroy large areas of forest and gouge the earth's surface. The working group suggested changing the size descriptors to sluff, medium, large, very large, and extreme. The assembly approved this proposal, but elected to implement the change in the 2018-19 operational season.

Avalanche warning services in many of the member countries use a matrix tool to help forecasters determine the appropriate level of the European Avalanche Danger Scale. The Bavarian Matrix uses the distribution of hazardous sites and the probability of avalanche release to determine the danger. The system includes the size of the load and considers spontaneous and artificial releases. The proposal was to add avalanche size explicitly into a portion of the tool to address situations that are ambiguously described by the matrix. This proposal was accepted and the new tool was named the EAWS Matrix. The rest of the first day was dedicated to electing new leadership and committee members. Norway was selected as the host country for EAWS 2019.

Day two of the EAWS meeting was a mix of presentations and panel discussions. Frank Trenchel (WSL Institute for Snow and Avalanche Research SLF, Switzerland) presented an investigation of avalanche danger levels across the Eu-

ropean Alps. He collected danger ratings from 22 centers and 250 forecast regions over four winters. His analysis tackled many of the intricacies in the data set, but some broad results were that the danger ratings of forecast centers with abutting zones were consistent 62% of the time and centers used levels 4 and 5 differently up to 15% of the time. Samuel Morin (Meteo-France) and Fabiano Monti (AlpSolut) presented the work of an international group that is applying physical snowpack models to support operational avalanche forecasting. Fabiano also presented some of the tools that accompany the SNOWPACK model (METEOIO) and provided examples for how you can use them with observation data in an operational setting. Christoph Mitterer (LWD Tirol) presented a summary of public avalanche bulletins across Europe. He identified similarities (spatial and temporal assignment of danger levels) and differences (text vs infographics, issue time, forecast period, and frequency).

Vincenzo Romeo (METEOMONT Carabinieri, Italy) presented a summary of the January 2017 avalanche cycle and accident in Abruzzo, Italy. The avalanche struck a 4-star hotel trapping 40 people and killing 29 of them. The slide released at the end of a large snow and wind event (2 m of snow in 3 days) that occurred during a period of unusually cold temperatures with a basal weak layer in the snowpack. It ran well beyond the previously observed runout zone destroying 530 hectares (1309 acres) of forest that was 60-90 years old. The story came straight out of a 1970's disaster movie, with people stuck in a hotel for several days after the avalanche, rescue efforts hampered by bad

weather and earthquakes, and a helicopter crash that killed the pilot and several rescue workers. This must have been a horrific event for the survivors and extremely challenging for the rescuers.

The members of the EAWS invited a group of stakeholders, including members from large alpine clubs, for a panel discussion. The topic was challenges of avalanche bulletin users. A representative from the German Alpine Club gave a presentation on their perspective that started with a statement something like "I want to congratulate you on your work because we have the best avalanche forecasts in the world. The only problem is that we cannot find the information and when we do, we don't know how to use it". This led to a fruitful discussion on both real and perceived problems and challenges with avalanche bulletins throughout Europe. It was a very interesting discussion to watch and as public safety forecasters from North America, I was both jealous of being able to speak with people that represented a large group of users and frightened of what similar groups in my area would say.

The 19th meeting of the European Avalanche Warning Service was a tremendous opportunity for me to interact with colleagues that work across the Atlantic Ocean. I would like to thank the Bavarian Avalanche Warning Service for hosting the meeting and all of the EAWS members for the warm welcome and interesting discussions. I hope there will be more opportunities to collaborate on common projects and make progress on issues that affect public avalanche safety programs around the world. Start planning your trip to Norway for 2019! ▲

LET'S BREAK TRADITION—AND SAVE MORE LIVES

Using snowmobiles for avalanche rescue

BY MIKE DUFFY AND BRUCE EDGERLY

Traditionally, snowmobiles have been used for decades to access accident sites. Once on site, the search is traditionally conducted on foot. We have developed techniques to use snowmobiles in the search stage to cut rescue times. In this article we present three ways sleds can be used to cut precious minutes in an avalanche rescue.

We have used these techniques in numerous environments: avalanche incidents, organized rescues, SAR trainings, and in practice scenarios with BCA employees. Lead author Mike Duffy has taught these methods in classes for six years with the Silverton Avalanche School. We are constantly refining these techniques and trying new methods. It's a learning process, but we have had successful results.



Snowmobile in avalanche debris, North Ptarmigan, Vail Pass, CO. Photos this page Mike Duffy

THREE WAYS TO SPEED UP AVALANCHE RESCUES USING SNOWMOBILES:

1. Accessing the debris for immediate visual/signal search

Get right to the debris—and through it—faster with a snowmobile. A sled can cover ground very fast through most avalanche debris and makes uphill travel much faster. You can get right to the last-seen-point and then continue downhill on foot or skis (assuming the snowmobile is equipped with a ski rack).

This photo is from an avalanche on Vail Pass in 2013. The body had been recovered, but members of Vail Mountain Rescue needed to “clear” the area in case someone else had been buried. The avalanche had not run full path for many years, so hundreds of trees were taken out, many in places that had been considered to be “islands of safety.” Despite the rough surface conditions, the snowmobile proved to be extremely effective. I was able to ride the sled up the debris, starting from the bottom, and do a quick visual and transceiver search in approximately ten minutes. We then switched to skis (with skins) and had five searchers cover the same area using parallel search strips, also starting from the bottom. It took the five searchers 45 minutes to cover the same area that the snowmobile had covered in 10 minutes.

2. Moving searchers to locations quickly

Rescue organizers can **use snowmobiles to get multiple searchers** to the most likely burial areas right away. Nothing is worse than taking 15 minutes to get to the most likely burial area, then finding a visual clue—but too late for a live recovery. A snowmobile can get you and several others there in a matter of seconds. The bigger the avalanche, the more effective sleds can be for this purpose.

TRICKS FOR TRANSPORTING SEARCHERS

There are several options for transporting searchers. Each rider can ride solo. You can also ride “Canadian” with one person on each running board: one person controls the brake, while the other controls the throttle. The brake is used as a last resort, as it can easily pitch both riders forward and off the sled if used abruptly. A tether switch that cuts the engine is highly recommended.

It's best to approach the hill straight on, to prevent tipping. If you need to sidehill, it can be better to have one rider straddle the seat while the throttle rider has both feet on the uphill running board. Effective sidehilling requires the snowmobile to be on edge with the downhill ski in the air.

The photo below shows the authors riding Canadian while towing a skier. The skier is being towed with a 7mm-9mm cord 20-30 feet behind the sled. The towed skier has a mountain bike innertube that is doubled over and held around his waist with a carabiner. About five feet from end of the rope is a butterfly knot with a locking carabiner. The end of the rope goes through the carabiner, around the waist, then to the carabiner on the butterfly knot. This results in a 3:1 quick releasing system that takes very little effort to hold with (cold) hands. The rider holds the tail of the rope; if he or she falls and lets go, it self-releases. The inner-tube absorbs shock from the snowmobile as slack is removed.





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WHICH SNOWMOBILE TO USE FOR RESCUE AND HOW TO SET IT UP

By Mike Duffy

The Snowmobile: The type of snowmobile used (utility vs. deep powder) is a common debate. Here's my thinking: Getting stuck will delay the rescue substantially. The two-up utility snowmobiles that most ski patrols and many mountain rescue teams use are not the best tool for getting into difficult terrain. They're too heavy, can't get to many areas and take too long to get unstuck. For backcountry rescues, light and fast is the way to go. I have been using Ski-Doo Summits for years. They are extremely reliable, low maintenance, have a "LINQ" system to easily attach extra fuel, ski racks, two-up seat and tunnel bag. At the end of the season with the Etec engine, add fuel stabilizer, start the sled, hit a few buttons and it lubricates the engine for summer storage. Doesn't get any easier. Track length. 163" or greater for deep snow. The longer the better. Engine size: Horsepower matters. 800cc or bigger two stroke.



Riding Gear: We use motocross helmets with goggles. Cold temperatures require face protection, balaclava. Also have spare goggles and clear lens for night riding. Motocross helmet prevents fogging and allows you to breathe better, especially when digging. Bring spare gloves and extra layers. Most snowmobiling rescuers don't use an airbag pack bigger than 30 liters. I use snowmobile-specific airbag packs that have less swing weight, lower profile, don't hit the helmet and are designed for aggressive riding.



Photo Jeremy Mercier

Gear storage: Less weight on the rider makes for less fatigue and more maneuverability. I carry first aid, survival, and avalanche gear on me. The non-essentials are in a tunnel bag. In snowmobiling



when using airbag packs, we carry two shovels. One on the rider, one on the snowmobile. If you get stuck, you pull the shovel off the tunnel bag instead of taking off your pack to access the shovel. This gives you the safety of the airbag at all times. If the sled gets buried, you still have a shovel.

Ski Racks: On rescues we carry a second mode of transportation. Sometimes the snowmobile will only get you so far and we switch to skis. I prefer racks that are in line with the tunnel of the snowmobile, easily removed and light. If you roll the snowmobile, you don't break the skis. Not a fan of ski racks with tall metal uprights that are above the tunnel. If you come off the snowmobile, injury can result from hitting the uprights. I use the Ski-Doo LINQ ski/snowboard rack.

12 Volt adaptor: Great for running auxiliary lights and running/charging devices (GPS, cell phone). Stock snowmobile headlights can easily get covered by snow in deep powder. Many riders use helmet mounted lights to see when the going gets deep. Frankensled Backcountry 8.4 light and Lead Dog Helmet light are good choices. I use a handlebar mounted Ram Mount for my Garmin Montana GPS.

Communication: I prefer not to have radios on my chest, they tend to break ribs when you bounce off the handlebars. I wear a protective vest when riding (BCA MtnPro Midlayer vest) or an airbag protective vest. Body of radio is in pack, with BC Link remote mic clipped to shoulder strap of pack.

Hand signals: If you pass snowmobilers going the opposite direction on a trail, they may be using hand signals to let you know how many are following. Number of fingers held up indicates how many riders are behind that rider. Last person in group holds up a closed fist to indicate they are the last one. It's a system that is universal in the U.S. and works well.

At Silverton Avalanche School we set up an avalanche rescue scenario on a hill with five victims (three with transceivers and two without transceivers but with visual clues). Five rescuers will be involved. We typically have two on snowmobiles driving to the farthest most likely burial areas, performing a visual search on the way. Once they get to that area, they step off the snowmobile, turn it off and do a transceiver/visual search on foot. Level I students are consistently pulling off these scenarios in under ten minutes, with the record being in the four-minute range. These scenarios are on relatively large slopes that exceed 100 x 100 meters.

3. Searching from Snowmobiles

Using snowmobiles to do transceiver searches? How does that work? Quite well: we've found that you can easily cut search times in half. Let's say you're the first on scene and have a large area to cover. Use the sled to cover ground faster for the visual and/or transceiver search. Here are some techniques we have developed, practiced, and found to reduce search times considerably:

1. Keep the ignition switch tether unhooked, so you can keep the engine running when you get off the sled. Use your best judgment here on safety.
2. Keep your transceiver easy to access. The BCA Float MtnPro Vest has an easily accessed, yet well-protected transceiver pocket on the outside.
3. Drive quickly to the debris and get up on it with the snowmobile. Stop and set the parking brake.
4. Keep the snowmobile running (it can be awkward to pull start when tilted). Step at least three feet away from your sled, to avoid electrical interference from snowmobile electronics. BCA testing has found that searching within three feet of most sleds (and six feet of the Polaris Axys) will often reduce receive range and/or cause "false triggers" in the distance/direction display. The snowmobile can be turned off to stop the interference, but many need to "power down" for 20–30 seconds for the interference to subside. Usually it's faster to leave it running and get off the sled to resume searching.
5. Rotate your transceiver on all three axes to pick up a signal as early as possible. Look for visual clues.
6. If you capture a distance reading and directional arrow on your transceiver, walk a few steps to see if the numbers decrease, to confirm direction.
7. Get a visual on the direction/distance the transceiver is pointing, then use the snowmobile to get to that location.
8. No signal from your transceiver? Continue your search pattern, stopping within transceiver range. Ride into the middle of the debris or continue around the perimeter, depending on the size of the avalanche and range of your transceiver. You can also use a signal search pattern (see transceiver owner's manual). It all depends on the size of the avalanche. Stop your sled within the range of your transceiver and repeat steps 4, 5, and 6. You should be looking for visuals the entire time.
9. Once you get closer on the coarse search, stop the snowmobile, pull your extra shovel off your tunnel bag and proceed on foot with the coarse and fine search. If using an airbag, we recommend carrying an extra shovel on your sled—preferably secured to a tunnel bag—so if your sled gets stuck and you need your shovel to dig it out, then you don't have to take off your airbag pack.
10. Probe to pinpoint and start digging using strategic shoveling techniques.

Learning to ride

Advanced riding skills are needed for most of these techniques when riding on avalanche debris. A rider accustomed to sledding on groomed terrain will have a difficult time. If the riding skills aren't there, it will be faster to travel on foot or skis. The good news is that there are backcountry snowmobile riding schools. These schools will teach you advanced skills in one or two days. It will change your perspective on what a snowmobile can do and will increase your skills enough so your sled can be a valuable and fast tool for avalanche rescue. BCA has put its entire sales and marketing staff through an advanced riding clinic with hillclimbing champ Bret Rasmussen. For more info, see www.riderasmussenstyle.com. ▲



Rider: Jeremy Mercier. Location: Grand County, CO.
Photo Brian Brown



Even a rescue scenario is a hectic situation. Practice at the Silverton Avalanche School has led to a number of innovations. Photo courtesy Bruce Edgerly

BCA has recently produced an instructional video on using snowmobiles for avalanche rescue. It can be downloaded and used for instruction by visiting www.backcountryaccess.com/education (videos page.)

DECISIONS. At the Opus Hut.

By Jeff Dobronyi

I awoke at 0600 to the sound of my cell phone alarm pinging in the dark bunkroom of the OPUS Hut. I was fast asleep, but as soon as I opened my eyes, my brain was in high gear. Throwing the blankets aside, I stood up and put my face to the window and cupped my hands around my eyes on the glass. After a few seconds, the dark scene came into focus. Still snowing.

I quietly stirred my co-guide Mike, who was sleeping next to me. We dressed and walked downstairs to the wooden door of the hut. Mike flicked the switch to turn on the porch light outside, and we looked at each other in the dark of the boot room, both nervous and uncertain. With a creak, the door swung open, and we looked out into the early morning. Snow was piled up to the porch railings.

Shit.

The OPUS hut sits near treeline at 11,700' on the south flanks of Lookout Peak, perched between 3,000 foot avalanche paths that run to the valley bottom and up the other side. Access is via the Ophir Pass road, which runs from U.S. highway 550 north of Silverton to Ophir, a small village just south of Telluride. Ophir Pass and the Middle Fork of Mineral Creek, also known as Paradise Basin, hold some of the best skiing in the San Juans. Over the course of three miles from 550 to the hut, it is mandatory to cross three major south facing avalanche tracks that hit the road starting at size D2. The start zones are wide, concave slopes, with southeast, south, and southwest exposures, on a ridgeline over 13,000'. Two of the paths cross the road in tight gullies, with only 100 feet of road being exposed, but the largest path, the Sound of Music, is more planar. The road is exposed to this path for almost a quarter mile. OPUS hut policy is to refund all guests who choose not to approach the hut when the backcountry avalanche danger rating is High or Extreme.

On March 23, 2017, I was guiding a group of ten high school students from Boulder and their two chaperones on a five-day backcountry skiing trip in the San Juan Mountains. It was day four of the program, and the second day of our three-day trip to the OPUS Hut. The plan was to ski corn all day until the kids got tired, and call it a day before a potent winter storm arrived later in the afternoon. We were expecting a classic Pineapple Express system, warm and wet, which typically provides the San Juan with feet, not inches, of new snow.

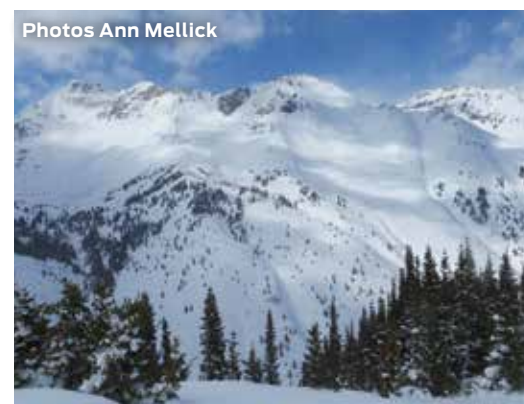
The winter of 2016-17 had already been anomalous in the San Juan, with a deeper-than-average snowpack mostly devoid of reactive Persistent Weak Layers (PWLs). Our first significant accumulation didn't arrive until Thanksgiving, delaying basal facet formation. The snow kept coming with warm temp regimes, and didn't stop until February. Nearby Coal Bank and Molas Passes broke their 1-month snowfall records with rough-

ly 150 inches in January. February and March provided the warm, dry, sunny Colorado weather that everyone loves to hate. I was having trouble finding depth hoar to show avalanche course students, which was a new problem for me. Overall, we were enjoying Open Season conditions and skiing lines that we had been looking at for years. By late March, we observed spring diurnal conditions on southerly aspects and cold skiing on the northerlies. Southwest aspects were mostly bare. So, when we marched our group of 12 beginner backcountry skiers up Ophir Pass road, Mike and I were feeling good. But on the evening of March 23, things got interesting.

The storm arrived in the middle of the afternoon. By then, our students were inside the hut, drinking hot chocolate and nursing sore legs. Mike and I looked at the CAIC weather forecast and started to run some scenarios. Plan A was to wake up on the 24th and ski directly to the cars on highway 550. Our students were on spring break, and they were planning on driving the six hours back to Boulder that same day to catch flights, take other family vacations, etc. We had already seen the 10-15 centimeters forecasted for the day with moderate southwesterly winds. 25-30 centimeters were forecasted overnight, with winds shifting towards the northwest and north by morning, perfect for loading our problem paths.

Our mission became clear: to forecast the probability of natural D2 storm and wind slab avalanches in the three avalanche paths affecting our egress to the cars on highway 550, and then to decide how and when to cross these paths. Before bed, we set a criterion for our decision: if we awoke to 40 centimeters of new snow plus sustained moderate NW/ N winds, we would stay put at the hut. It sounded like an easy call. But when Mike and I opened that door on the morning of the 24th and saw the snow drifted up to the handrails on the porch, I knew I was in for a hell of a day.

The avalanche paths:



TOP: Above the Opus Hut with the Battleship and Paradise Basins in the background.

CENTER: Looking back from the hut towards Highway 550, which is at the bottom of the valley. The road crosses under all of these paths on the left.

BOTTOM: Access road to the Opus Hut.

Photos Avery Stonich

At 0615h, we measured 50cm of new snow overnight with drifting up to 120cm. Winds were moderate from the northwest, which meant critical new snow and wind loading 2000 feet higher in our start zones. Weather stations and the 0700 CAIC forecast confirmed 50cm new snow around the zone with sustained northerly winds of 20-30 mph. US 550 over Red Mountain Pass was still open, but we also received a report that Eagle avalanche path had slid naturally, which is a south-facing avalanche path on a similar ridgeline about one mile away from our area of concern. The avalanche danger was rated Considerable, but Mike and I rated the likelihood of natural avalanches in our paths of concern to be "likely." Sensitivity was predicted to be "very touchy" and size to be "D2-D3".

Mike and I unfolded the predicament in front of us. Of course, we were staying put, at least for a while. Images of the Connaught Creek accident flashed before our eyes, and the Ophir Pass valley is not unlike the terrain on Rogers Pass that killed seven schoolchildren in 2003. But after receiving word from the hut keepers that 16 new guests had decided to leave Silverton and were attempting to access the hut, we immediately felt pressure to get out to the road that day. 30 people in a hut built for 16 is a problem. The new guests would be unhappy that we decided not to leave, when they saw no danger in crossing the avalanche paths. The hut owner was pressuring us to leave via text. Kids would be bummed that they wouldn't make it home that day. Parents would be mad about missing flights and ruined vacations. We took the time to write a list of all these pressures in our guide's notebook. A lot of people would be pissed off if Mike and I decided to stay at the hut another night.

If Red Mountain Pass had been closed, there would be no way to drive home once we got to the cars. If the danger rating had been High, we would not be charged another night and the next group would not have come up to the hut. If we had been using a firm company decision-making matrix, our decision would have been made for us. Unfortunately, none of these were the case. If we stayed, people would be angry. If we decided to leave, and got avalanched, that would be the end of our careers, or worse.

After forming an initial hypothesis about the snowpack, we went outside to clear our heads, get some data, and do what we do best: ski. We weren't going to be leaving anytime soon, so we took the kids for a run down a 25-degree south-facing open slope below the hut. The skies had cleared and by 10 am the air temp was above freezing. Somehow, there was no avalanche activity in the whole valley! The new snow was mostly well bonded, with easy hand shears in the top 10cm being the only problem interface on that slope. It became clear that we had very little experience dealing with 50cm storms falling on a stable spring snowpack. As Colorado ski guides, we





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were used to reactive PWLs and small incremental loads. This storm, which dumped 50cm of right-side-up snow on a stable base or bare ground did not have an account in our experience “bank.” We had no idea what was going on. This unfamiliar pattern did not compute.

Desperate for the opinion of those who might have seen this pattern before, we called in the cavalry. I texted some of my mentors, Josh Hirshberg (former CAIC forecaster for the North San Juan) and Angela Hawse (snow safety director for Telluride Helitax). All I needed was a good reason to stay at the OPUS hut another night, and I would have been happy. But they had no new avalanche activity to report, neither in the Telluride zone or on Red Mountain Pass. Josh was in the field with a Level 1 avalanche course that day, and the regional noon radio check in reported no signs of instability at the new-old interface, which jived with the data we found on our slope. Mike and I were in disbelief, having just gone from forecasting High danger and many natural avalanches to seeing no activity, natural or human triggered.

Still, all of this data took a back seat to the task in front of us: to safely guide 10 minors and their two chaperones through three large avalanche paths. Assuming it would take one minute per person to cross each path, our calculated exposure time on the way to the cars would be 45 minutes, less than 12 hours after snowing 50cm! Were we crazy for thinking it was a bad idea? I still don't think so.

The day warmed up, pow turned to hot pow, and the top 30cm became more reactive in snowpack tests, failing on the drier snow below. Still, no natural or human triggered activity was observed or re-

ported. Angela and Josh were aware of the pressures and consequences we were facing, and they were helpful by supporting our conservative approach. Angela suggested that if the storm snow did not avalanche naturally right after loading, and did not avalanche naturally during the heat of the day, then we could be more sure of stability as the snowpack cooled down in the evening. Josh agreed. Mike and I were less sure, but we understood the reasoning and decided to set a departure time for 1700h from the hut, knowing we could turn back if we got bad vibes. This would get us down to the cars around 1900h, half an hour before dark.

In the end, we safely crossed the paths after 1800h. By then, the melted surface of the new snow had re-frozen into a 1cm sun crust. Skiing down the road went quickly because the next group of OPUS hut guests had broken trail earlier in the day. At each avalanche path crossing, I nervously posted up in a safe spot to direct traffic and signal for the next student to cross, head on a swivel between each young skier and the start zone.

So, did we make the right call? I'll never know. Looking back, if we had not made any communication with the outside world, and had no pressure to descend, I probably would have stayed at the hut and tried to head to the cars the next morning. I would like to think that our decision to change plans and descend in the evening was based on observations, mentorship, and open communication and consensus between guides and other snow safety experts, but I can't be sure that those outside pressures didn't affect our decision. After a margarita and a long night of sleep, we debriefed the day and found some useful takeaways.

First: realize when we are faced with an unfamiliar pattern. This day was the first time that I truly understood that “experience” thing everyone always talks about. Having a snow safety director to consult is a luxury that most backcountry ski guides do not have. When in doubt, seek higher wisdom or back off.

Second: the importance of communication. Between guides, Mike and I had to be comfortable sharing that we were both having trouble forecasting the likelihood of natural avalanches that day. It was nice to have cell phone service to contact our company owner, lead guides, and other mentors, but that is an anomaly in the San Juan and many other ranges. Radio comms with other guides in the area was helpful. On Red Mountain Pass, we have informally adopted a noon check in on the AMGA VHF frequency. Guides from all companies are encouraged to openly communicate about their route and pertinent observations. This requires camaraderie amongst the local guide population, which is also not present in many ranges.

Third: the pressures we feel to perform our duties and achieve our objectives will always impede our decision-making, but we must realize as an industry that our first job is to come home safe. Parents, other hut guests, and hut management vocalized their desire for us to descend to the cars, but our mentors, company ownership, and the faces of the students and the people we love compelled us to be conservative. In the end, I don't care who was inconvenienced by our late exit. I'm happy that we made it out safely, and I'm excited for the new patterns this winter will bring. ▲

Dear American Avalanche Association,

My name is Amanda Ballenger, my father was Walter Ballenger, Director of Ski Patrol and Snow Safety at Squaw Valley starting in 1962.

He also was hired by Disney to do the initial avalanche surveys in Mineral King, CA that resulted in a catastrophic avalanche, 93.5 inches of snow in 100 days. My father was buried in his cabin and one of his men was buried and died in another cabin. The story is remarkable. My Father survived after being buried for a number of hours and digging out of a shaft to a flattened valley floor, it is an incredible story. My Father was also a writer so his narrative is great.

I have all my Father's snow logs and a story chronicling the event (Winter 1968). I have been urged more than once to submit it as it is an event that is noteworthy as well as historic due to the men involved. I have a picture of my Dad and Monty Atwater in the back of a Thiokol inspecting a gun. Monty highly suggested they abandon the project which they did not.



MINERAL KING

A World of Avalanches: Part 1

By Walter Ballenger

Transcription help by Ginny Newsom

There's a day towards the end of August each year when the sun chill comes to the California Sierra, serious gusts of wind out of the southwest raise the summer dust. The sky is heavy with angry grays and the lower cloud layers scud by so quickly that the mountain peaks seem to tilt. On such days, avalanche hunters—those men who attempt to control the snow slides in the various ski areas and above mountain highways in mining camps—feel the change in wonder of what the approaching storms of winter have in store for them. Some remember past winters too, and perhaps spend a sleepless night, anxious and sweaty, recalling past mistakes, errors of judgment, avalanches which almost caught them and those which took their toll despite their efforts, as

if in defiance of their meddling. This is what happens to me now—nightmares I can't rid myself of, a sudden sadness, fear. But on such a day nine years ago, in the early fall of '68, I remember only the excitement I felt as the first signs of winter arrived. I was in on something big. I had just been hired by Walt Disney productions to help Dave Beck, another avalanche hunter, with the snow and avalanche survey then being carried out in their proposed ski area at Mineral King. Our main work for the coming winter, as defined by Willie Schaeffler, the technical advisor for the project, would be to learn if we could control the inherent avalanche problem throughout the area, and if possible, to begin a program to establish that control.



Editor's Note: Mineral King is now part of Sequoia-King's Canyon National Park. *Topozone*.

To say that this was the challenge of a lifetime for an avalanche man would be an understatement of fact. Monty Atwater, the father of avalanche hunters in the Western Hemisphere, had called Mineral King, "...unquestionably one of the greatest and most difficult developments of all time." Andre Roche, chief of the Avalanche Research Center in Davos Switzerland, had already stated, point-blank, that it couldn't be done. Everywhere among avalanche men—most of whom had seen Mineral King at one time or another—it was the main topic of conversation; some for it; others against, but very few neutral on the subject. As for myself, I was certain it could be controlled. I had seen Mineral King that May and had skied much of the area with Schaeffler, Emile Allais, and Dave Beck. It was, without a doubt, a world of avalanches. And I remember the pride I felt that my skills as an avalanche man were such that Disney Productions had seen fit to hire me.

Certainly, I had no trouble resigning my job at Squaw Valley. At the time, I was engaged to a girl named Faith. (We would be married the following spring when it was all over.) Now we talked eagerly of the possibilities the job offered for the future. Nothing but good could come of it. I was packed and ready to go weeks ahead of time. I had no forewarning, no anticipation at all, of the bitterness that winter would bring, of the terror it held in store for us, of the 20-year-old boy with the blond hair and a shy smile who would die there on February 24, 1969, in the same manner as two pit miners had during the gold rush days a hundred years earlier. Nothing of that. Only that I was on my way to help develop the largest and finest ski area ever to be proposed in this country, one which would certainly become comparable with those in the Alps.

Actually, there is no mountain named Mineral King. There's Mineral Peak at 11,550 feet; Mineral Queen a little lower; Empire Mountain; Sawtooth Peak at 12,343; Vandever at 11,947; Tulare—renamed Disney Peak, then back to Tulare again—about the same. Others. Mineral

King itself is a Post Office, open only in the summer. It lies at the upper end of a twenty-three mile, snake-like road which begins at Three Rivers, a resort town near the town of Visalia. It's the kind of road only a fool would drive for pleasure. But they do, by the thousands. The rising river cut which the road follows is spectacular; the building-sized rock formations awe-striking. There are redwood groves and deep fir-filled canyons. There is smog in them now.

In Mineral King there's a store, a gas pump, and a number of tin roof summer cabins, brown and Forest Service green weathered to blend. On the porches are stacks of short cords for the potbellied stoves; it is cold at night at 7,830 feet, even in mid-July.

In summer it's a camper's paradise, backpackers on every trail. Brown bears hang out at the village dump and beer cans glitter in the adjacent meadow like fool's gold. On hot days, the air smells of outhouses and children are lost, but most visitors can only gasp at the grandeur of it all.

In winter, Mineral King is deserted. Hemmed in on three sides (Miners Ridge to the west; the Potato Patch walls to the east; Empire Peak to the north). The village looks like a toy town wedged in at the bottom of a pit. Wolves and coyotes return; hawks circle in the graying sky. Deer sniff approaching storms and when the snow comes, weasel and rabbit make continuous tracks.

From the village the valley slants upwards again, this time southward in a narrow glacial "V" to Farewell Gap, a pass at 10,587 feet. Steep peaks rise on either side, sheer in places, cliff ridden, boulder strewn, the upper regions greased with grey black shale. The lower slopes are thick with pine, fir, hemlock and aspen, choked with brush. Behind the peaks forming the eastern aspect of the valley (named Farewell Canyon fittingly) are more peaks—White Chief at near 11,000 feet, the Mosquito Range. Huge bowls fall away under them, long steep faces. Between the peaks are vast stretches of high meadow land, this terrain sloping more gently into the distance, dotted with lakes and sudden cliffs, like earthquake faults in a Jules Verne novel. These peaks, along with the canyon itself would be the ski area.

The history of Disney's Mineral King project is well known and fully documented. The court battles which lasted for years might well be called the classic confrontation between private enterprise and environmentalists over the usage of federally owned lands. No one denies that the development of the area would affect its natural course. But whether this effect would be adverse as the Sierra Club maintains or beneficial as Disney and the Forest Service claim is the question still up for grabs. The project has been essentially blocked in the courts and Mineral King remains in its natural state.

Less well known is what went on inside the area during these years of court hearings. There was no construction of course; but Disney did begin a series of studies preliminary to such construction. One of these, perhaps the most important of them, was the snow and avalanche survey. Begun in February 1966 by Bill Stark and Gary Poulson, the survey ended abruptly three years later in February 1969, in the midst of one of the fiercest winter storms ever recorded in the Sierra. What follows (much of it taken from the records, daily log, and my diary which were kept at the time) is the story of those last few days; or a part of the story anyway. Because the whole of it will never be known with certainty.

From the Mineral King daily log:

October 21, 1968

Temperature: Low 39—High 71

Barometer: 1008, Rising

Wind: None.

Conditions: Clear and warm during the day,
Clear and cold at night.

Unpacked... then discussed routines with Dave.

Dave Beck knows as much about avalanches as any man alive.

He learned his trade as a ski patrolman. First at Sugar Bowl, then at Squaw and Alpine Meadows—all areas of high avalanche incidence. Short, almost squat, he has legs like pile drivers, a barrel chest and the weathered face, the perpetual squint of a mountain man. I've seen him break trail uphill through heavy powder snow for hours on end. We were close friends; worked together at Squaw for two seasons. In the summer of 1966 he was hired by Disney to continue the snow survey, begun earlier that winter.

He and his wife Susan lived in a cabin in the southern edge of the village, the side open to Farewell Canyon. In winter, they were virtually isolated from the outside world, their only contact being an uncertain phone line and a used Thiokol. The summer road, which the Thiokol followed, was more often than not blocked by potentially dangerous slide paths, the released avalanches themselves, which flowed over the road like giant mounds of lava, sometimes twenty, even thirty, feet deep, and fallen trees blown down by the gale force winds. On rare trips to Three Rivers, Dave carried dynamite and a chainsaw to blast and cut his way out. He worked alone, for the most part, constantly at war with the building snowpack, the short winter days, and the bitter cold nights.

Robert Hicks headed the project. A quiet man, soft spoken, with a round gentle face, Hicks seems to be preoccupied much of the time. But he acted, when necessary, with quick assurance and authority. He was the first man to fly around the world in a light single engine airplane. Willy Schaeffler, as I've mentioned, was the area's planning consultant. He was also, at the time, coach of the men's Olympic Ski Team. He was good at both jobs. Dave's survey records were sent directly to Hicks in Burbank, and there absorbed by Schaeffler and the Disney experts.

When I arrived on October 21, 1968, the survey was going into its third year. By then Dave had a full array of weather instrumentation, a well laid out snow plot and an established routine for snow depth measurements, pit analysis, and avalanche observations. This winter we would have the tools of an avalanche hunter as well—a supply of dynamite for hand charges, and Avalauncher (an air gun developed by Monty Atwater and Frank Pasonneault which could fling a projectile of black powder as far as two thousand yards) and a .75 recoilless rifle on loan from the Forest Service. Besides the telephone line which had been re-serviced over the summer, we now had radio contact too, with the Department of Agriculture, based in Porterville. A Forest Service snow ranger named Peter Wyckoff was assigned to the project. He would come in from Porterville every two weeks, if possible, to go over the survey records and fire the rifle.

It was a busy fall. I moved into the cabin owned by Bob Hicks. A board-and-batten box the size of a bedroom with a smaller sleeping alcove added to one side, it was located some two hundred yards north of Dave's cabin, more toward the center of the village. It had a shallow peaked roof. The treed slope of Miner's Ridge rose steeply above it to the west. In December, the sun fell behind the ridge as early as 1:45 PM. In the afternoon, we would turn the generator on for an hour so that I would have enough light to keep the mass of records current. It had

a stove, a fireplace, a propane heater, and a surface pipe for running water; but by mid-December the pipe had frozen solid, and we toted water from Dave's cabin in five-gallon jerry cans.

Helicopters came and went—Disney consultants, government VIPs, even on one trip a State Senator. The Disney teams were very efficient; they seemed to us as we stumbled about in our preparations for the winter, almost computerized. We joked about it, mountain men tending the needs of flatlanders. On November 8th Faith drove down from Squaw. She stayed for five days until a minor storm on the 12th had passed. I was glad she'd come. I'd caught a bug a few days before and felt terrible. She cooked decent food for me, straightened up the cabin, and helped me develop a system for the survey notations. She knew something about avalanches herself, having worked as a radio operator for Mountain Operations at Squaw. When she left (her young son had called; he had just come down with chicken pox), I felt much better; but Mineral King seemed very empty. I felt uneasy too, thinking of her alone in Squaw with her three small children. Winters there, in those days, could be hard.

By Thanksgiving this outside activity had stopped and we were left to ourselves. Besides Dave, Susan, and myself, two others stayed in Mineral King that winter—Randy Kletka, a boy of about twenty, and Gary Kirk, a little older. They weren't Disney employees, but rather friends of Dave who wanted the experience of a winter in the mountains. For Randy, it was the first such winter. Gary had spent time in the Sierra before, climbing and ski touring. Both were strong and tough. They lived in a cabin next to Dave's helping us throughout the survey, especially on Dave's climbs into the upper areas. Randy, in particular, wanted to learn about avalanches. He and I grew close as weeks passed, as storms cut us off from the outside world. Later in the winter, Will Kirk, Gary's younger brother, joined them.

On October 24th I climbed to Farewell Gap. There had been a storm the previous week with snow level at 9,000. Now below me, down canyon, the snow was patchy; but in the gap, at 10,000 feet, it was a true snowfield, eight to twelve inches deep. The wind was light, blowing up the valley. The peak glistened. I watched a long time. On the way down I noted a small wet snow and rock avalanche off the Vandever cliffs.

From the Mineral King daily log:

November 15, 1968

Temperature: Low 32—High 42.

Barometer: 29.40 and falling

Wind: None to very light, Variable

Cloud cover: Full overcast AM and PM.

Precipitation: Snow and sleet

Gross snowfall: 18 inches

Duration Major Storm: 13 ½ hours

I note in my diary that this is the first real storm of the season. It's late by Sierra standards, less severe than predicted by the forecast; but in the light of future events, it will prove a most important one. Because when it was over, the temperature dropped and the weather remained clear and cold for almost a month—external conditions conducive to the formation of Depth Hoar in the pack.

Depth Hoar—the avalanche man's nightmare. Rounded lumps of snow at ground level. A non-binding layer of snow crystals deep in the pack. It's only a matter of time, of added weight—both unpredictable. The depth hoar layer collapses; the crystals become ball bearings, and the entire snow cover comes down—the climax avalanche,

the biggest and most destructive of them all. We don't see much of this in the Sierra, because most of the ski areas like Squaw Valley lie in the lower coastal zones with warmer daytime temperatures. Depth hoar doesn't get a chance to form. But Mineral King, like Alta and the other resorts in the Rockies, is high. It's cold and dry, and the wind in the upper regions reaches gale force.

On November 27, Randy Kletka climbed Miner's Ridge and poked around the Eagle Lake area, just under 10,000 feet. He reported the snow depth of 14 inches with 22-inch drifts. There was a 2-inch surface crust with soft granular snow underneath. It was cold, most of the slope being in full shade. From this, Dave and I assumed the worst; and a week later, on a two-day tour of the upper area, Dave confirmed it. He found depth hoar deposits forming throughout the area. I noted these findings in the log. It snowed again on the 10th and the 14th. By the 22nd, the depth hoar crystals were almost mature.

From the Mineral King storm report Number 5:

December 25, 1968. Christmas.

Technical Details

Began: 8:15 AM. December 24th.

Ended: 4:00 PM. December 26th.

Duration Major Storm Period: 56 hours.

Old Snow Depth: 25 inches

Gross Snowfall: 29 $\frac{3}{4}$ inches

At 8:00 PM I sit alone in Hicks' cabin and listen to the avalanches crash down around me. Some distant; others close. The kerosene lamp on my desk casts odd shadows as I write. They seem to jump with each rumbling slide. At 8:30 Faith calls. The phone line, thank God, is still up. Usually in weather like this the service it out. The storm, Faith tells me, is vicious in Squaw too. We try to sound happy but it's of little use. I worry about her, wonder if someone will help her dig out when it's over. I don't tell her about hearing the avalanches. Hicks' cabin leaks like a sieve. I write in my diary that it's a white Xmas all right, but a gray one too. On the 27th we dig out and take stock.

In the days that followed we found evidence of eleven major avalanches. The debris piles were huge, indicating climax activity. We knew that there had been dozens of other slides as well, but the tail end of the storm and the snow which fell again on the 28th obliterated the evidence. It puzzled us. The cycle had been a major one—the slides large, numerous and extensive, but considering the amount of snow which fell during the storm and that which was already on the slopes, this extensive activity seemed unwarranted. We blamed the depth hoar, of course, but I felt there was more to it than that. Though what it was, I didn't know. The peaks around us remained silent. One thing, however, was proved. The avalanche problem in MK was severe. We had our work cut out for us.

On the 30th, four days after the storm, using the .75 recoilless rifle, we shot a Class 5 (climax) avalanche off the north-facing slope of Empire. The delayed action of the slide was a surprise and worried us further. We wondered how many more were still up there waiting.

The next day, after Wyckoff had left for Porterville, Dave and I moved the rifle to an alternate site (a twelve-foot platform) on the other side of the creek, away from Empire. The rifle had sat on a rather high mound at the foot of the mountain, but the depression in front of the mount had been partially filled in during the storm. One more snowfall and the depression would be leveled; and though the slide we had triggered hadn't run the entire slope, others would. We'd look foolish, we felt, being hit by a slide of our own making.

Six more storms hit us during the latter part of January. One of them on the 18th lasted 36 hours and dropped 51.5 inches of new snow. The Christmas avalanche cycle was repeated. We counted six during a break in the weather without leaving the village. One of them, off Empire, stopped inches away from the first rifle site. I could span the distance between the gun platform and the debris with one hand. Another, off Miner's Nose, stopped only feet away from one of the empty cabins. The valley took on an unreal appearance. An entry in the report for storm number 7 notes that the entire area was extremely hazardous, and would be for several days to come.

Trips into the upper areas were necessarily limited, and for the most part all of us were confined to the village. We shoveled continuously, doorways and roofs. The cabins leaked, were cold and damp no matter how much wood we burnt. One of the slides, up valley, had knocked out the water supply to Dave's cabin, and it took us two days, digging through ten feet of debris to repair it. The sky was leaden. It seemed as heavy over us as the slopes were around us. An avalanche off Empire sounded like an earthquake. A form of depression set in. And a certain disruption among us.

We bickered. Susan, an environmentalist before her time, became actively anti-Disney. She wanted the development to be stopped, MK to remain as it was. I argued with her, a company man throughout. Dave vacillated from one extreme to the other. Angry at me when I complained about our living conditions, he seemed to thrive on the hardships, taking unnecessary risks on his movements outside the village. I pushed at him constantly to keep up the more mundane aspects of the survey such as snow pits and ram profiles. The Kirk brothers kept to themselves. Only Randy seemed immune. He mediated among us the best he could.

The storms continued. Climaxes off High Bridge and Juniper Ridge blocked the road to Three Rivers and we used cases of dynamite to blast a path for the Thiokol through the twenty-foot mound of debris. Three wet slabs came off the Potato Patch and crossed the creek, one of them coming to rest against an empty cabin by the bridge. Our world narrowed, and we began ruling out one expertly proposed construction site after another.

Unable to use their rifle because Wyckoff was kept away by the storms (by law Forest Service personnel must be in attendance whenever it is fired), we watched helplessly as the build ups above us increased. In my cabin, I brooded about my children, two of whom, unhappy in Berkeley, had left their mother to move in with Faith in Squaw—an added burden for Faith which I felt responsible for. Wanting to be two places at once, I became unfit company for anyone. On the first of February, normally in the Sierra the stormiest month of the year, the snow stake on the valley floor read 102 inches. The stake in Farewell Canyon, some one thousand feet higher, was 163 inches—thirteen and half feet. What it was about that we had no idea.

From the Mineral King daily log:

February 6, 1969.

Temperature: Low 21—High 22.

Barometer: 29.45 and falling

Wind: Gale force, NNW.

Cloud cover: Full low overcast.

Precipitation: Heavy Snowfall

Visibility: Zero

In the afternoon, we play hearts in Dave's cabin—Dave and myself, Gary and Randy, Monty Atwater and a Disney cameraman named Carl Firth. Monty and Firth had come in earlier in the week during a lull in the weather—Firth to photograph Dave and myself at work; Monty to

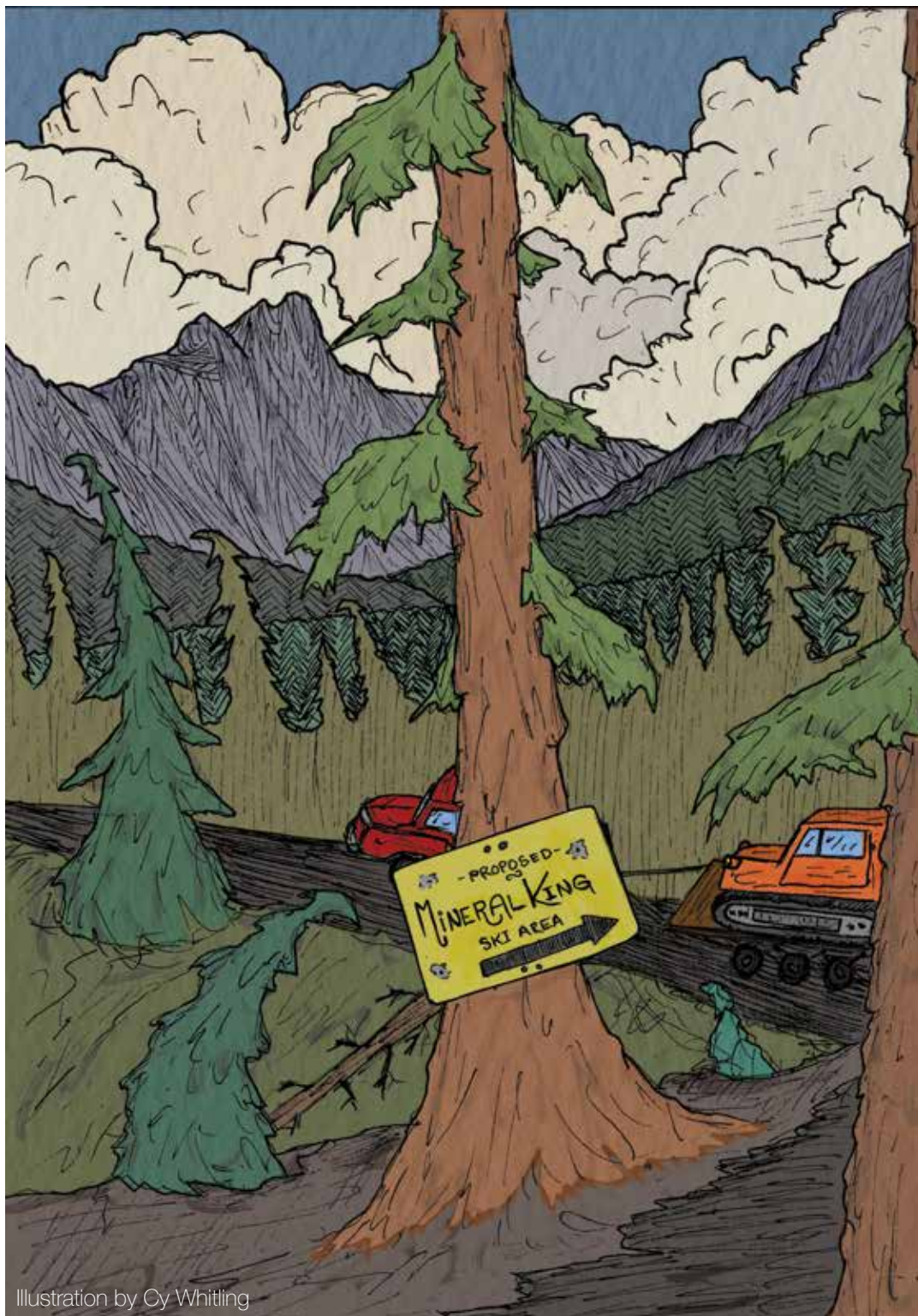
test a new (and safer) fuse assembly which he had developed for the Avalauncher's payload. The storm drops 38.5 inches of new snow. Now they're stranded, snowed in, unable to get out by Thiokol.

During the game Monty sounds a warning. He has been in storms like this before, too many of them. He suggests we all evacuate MK by helicopter as soon as the weather breaks. Dave and I reject his suggestion. We feel our cabins are safe; in the seventy-year history of Mineral King no avalanche has ever touched them. Monty thinks we're being foolish. In any case he wants out.

The phone line is down, of course, we turn on the generator and radio the Forest Service. Dave requests helicopter evacuation for Monty and Firth. This is arranged. Dave also asks permission for us to fire the rifle. This is denied. Monty takes the microphone. He is angry. He informs the Forest Service that we will fire the rifle, permission or not. The Forest Service, reluctantly, tells him we're on our own.

In the morning, we fire shot after shot into Empire Mountain and Juniper Ridge. The results are negative. We search for evidence of natural releases and find three. But they're small in relation to the amount of snow which has fallen and don't count. The pack just sits there and we can only hope that the shots have stabilized it somewhat. At noon Monty and Firth are flown out.

It snowed again on February 11th and again on the 14th and 15th. The snow stake on the valley floor reads 128.5 inches. Over ten and half feet. Two feet higher than the roofline of my cabin.



Stay tuned for part 2 in TAR 36.2...

From my diary and subsequent report to Disney Productions:

Monday, February 17, 1969.

I decide that any further snow survey work in MK, on my part, is unwarranted and a waste of company money. There are several reasons for this:

1. I am spending most of my time shoveling out and have reached the point where further shoveling seems impossible.
2. The snow depth on the valley floor is such as to make further readings or measurements meaningless. Installations such as lifts, ramps etc. can be constructed to cope with a certain amount of snow depth. However, beyond a certain depth, the design and cost of such installations to raise them about the snow surface becomes impracticable; and the solution lies in snow removal, not design. I feel this point has been reached. Besides this, wind scouring in the snow plot has made the stake readings inaccurate—i.e. much too low.

3. The avalanche hazard in and around the village area is becoming a real concern. Even though the Empire/Juniper slide paths have been shot periodically, I feel from my observation of these areas throughout the winter that they are now presenting an obvious hazard, shot or not. Also, there is still the High Bridge slide path to contend with, which cannot be reached with the rifle.
4. The Avalauncher, due to the failure of the projectile to explode on impact in the deep snow, is of no use to us for control work. Even if it were, it is doubtful that we could move the Thiokol up Farewell Canyon because of the depth of the snow. Further, with the buildups being what they are, it is inadvisable to even try.
5. I also feel that any trips on skis into the upper area would be much too dangerous for, at least, the next three or four weeks, even if the snowfall were to stop now. Weather forecasts indicate that this will not be the case.

EXTREMES OUTLIERS FUN FACTS

National Avalanche Center: The winter of 2016–2017 was impressive. From hurricane force winds in California to single digits in the Cascades to record snowfall in Idaho to rain-on-snow in Wyoming, it wasn't boring. Despite the unusual winter and repeated atmospheric river events which created several periods of widespread HIGH and EXTREME avalanche danger, **the number of US avalanche fatalities stayed in the teens** (12, maybe 13 depending on an ongoing Olympic National Park investigation).

Without trivializing the fact that families and friends are mourning the dozen lost to avalanches this season, it is important to note that this number is less than half of the 30-year annual average.

The US avalanche fatality trend is flattening (read more here: www.fsavalanche.org/news/2016/6/27/us-avalanche-fatality-trend-is-flat-for-the-past-22-seasons). We are hopeful that this trend continues, and that the great work done by educators, forecasters, community groups, and equipment manufacturers is paying off. The flip side is that it could easily go the other way...a couple of bad accidents per season is all it takes to point those numbers in another direction.

In this regard, we need to continue to move the bar forward. Although the rapid advance of technology is creating new opportunities in messaging and communication, it also has the potential to shift our workflow, budgets, and skillsets. Much of our focus this year was to lay the groundwork needed to be able to address future opportunities or challenges:

- We worked with the CAIC and AIARE to develop a video tutorial on Avalanche Problems.
- We worked with the avalanche centers to develop the new Avalanche Center Guidelines.
- We are partnering with the AAA to redesign/repurpose Avalanche.org. This initiative will:
 - Connect the public to avalanche forecasts, education, and resources.
 - Facilitate and house avalanche center technology initiatives.

Please give us a call if you want more details on these projects, or with anything else for that matter! Most importantly, we want to recognize the avalanche center group (and the snow and avalanche community as a whole) for providing an invaluable public resource. Thanks for the work you do!

—Simon Trautman and Karl Birkeland

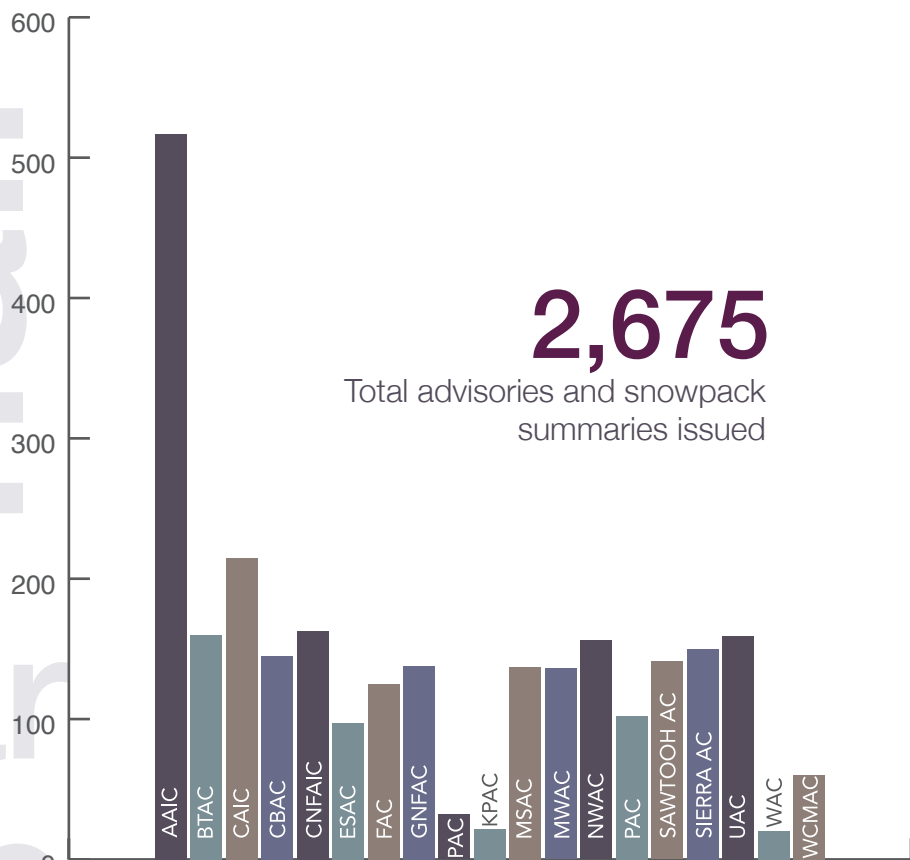
7 centers issued EXTREME ratings or warnings

EXTREME

12 avalanche fatalities in the US

perhaps reduced by

the 30-year average



These numbers indicate the number of days products were issued, with the exception of the AAIC, which features a combined number of the individual centers included within that organization.



Mount Shasta: This is the Old Ski Bowl weather station with a snow depth sensor. On this day we were troubleshooting a few problems. The sensor sits 20 feet off the ground, and at times this winter the snow came within inches of the bottom.
Photo Nick Meyers

MSAC **Mount Shasta Avalanche Center**

The US Forest Service Mount Shasta Avalanche Center finished its 19th season of operation with the winter of 2016/17. The region experienced one of the wettest winters on record, with Mount Shasta City receiving 56.81" of water (normal 37.16") between October 1, 2016 and April 17, 2017. This put Mt. Shasta City at 153% of normal. The significant statewide precipitation received this winter season ended California's five-year drought. Many areas in California experienced the wettest season on record. Although Mt. Shasta did not break the record books, it was certainly a winter

to remember. A few large early season storms in mid-October laid down a solid snowpack in areas above 7,000 feet and made for some of the best early season skiing and riding conditions in years. The winter really turned on by early December, and the advisory area rarely went longer than a week without receiving precipitation through April.

One of the most impressive avalanches on Mount Shasta occurred on December 17, two days after a storm deposited 20 inches of snow and 2 inches of SWE in a 48-hour period. A major NW wind event occurred from the 14-17 of December, and was very productive in loading SE aspects. In the early morning hours on the 17th, a natural wind slab avalanche occurred off of Casaval Ridge. The avalanche was 1500 feet wide,

ran for 2000 feet, and put 20-30 feet of debris on Lake Helen, a popular camp for climbers in Avalanche Gulch. That same afternoon, two skiers triggered and were caught in an avalanche in the Sun Bowl, a popular ski run on the south side of Mt. Shasta. The skiers were carried 800 vertical feet down open terrain. The two people involved were not carrying any rescue gear and were incredibly lucky to have not been buried in the avalanche. The MSAC forecasters were able to respond to the scene of the avalanche within 30 minutes of the 911 call. Upon arrival, both skiers were found on top of the snow and uninjured, bringing a wave of relief. Thankfully, there were no avalanche fatalities within our avalanche advisory area during the 2016-17 season. Our second

153%
of normal

Mt. Shasta
normal
snowpack

avalanche incident occurred in early March at Castle Lake and involved a solo skier who was caught and carried 100 vertical feet into trees becoming partially buried but uninjured.

January brought the largest storm event of the season. For seven days starting on the 17th, areas above 6000 feet received 7-9 feet

of snow. This period brought the most widespread avalanche cycle of the season. Mount Shasta City picked up 4-5 feet of snow and exhausted all snow removal efforts for local plows. The storm closed the primary backcountry recreation trailheads in the area for over a month, limiting access.

February was characterized by smaller storms and regular avalanche activity. A notable natural, wet loose avalanche ran and triggered a storm slab avalanche on a steep slope above Castle Lake. The flowing avalanche debris hit Castle Lake and fractured the lake ice.

The snow kept falling in March and April with bursts of sunny spring weather in between storms. Towards the tail end of the season, avalanche events became far less destructive. The corn skiing came in waves, and the powder skiing continued. Coverage on the mountain is looking great and we are gearing up for an amazing climbing season here on Mount Shasta.

The MSAC had three employees this season, the most number of employees the Avalanche

Center has ever had. Nick Meyers returned for his 8th season as the Director and Lead Forecaster. Andrew Kiefer filled a USFS position as a second full time Avalanche Forecaster. Aaron Beverly started with the MSAC this season as well, filling a part time Professional Observer position funded by the Friends of the Mount Shasta Avalanche Center. A total of 137 daily advisories were published on our website, www.shastaavalanche.org, between December 1st and April 16th.

The outreach and educational components of the avalanche center kept us hopping this year. The Mount Shasta Avalanche Center delivered 27 avalanche presentations reaching 567 people throughout northern California and southern Oregon this season. The MSAC provided four basic avalanche awareness and companion rescue clinics. There were several internal Forest Service employee avalanche trainings focusing on basic avalanche awareness and rescue. A training was also given to the Crater Lake National Park Ski Patrol and local school groups including the Mount Shasta High School Ski Team. One full day, snowmobile specific avalanche awareness and companion rescue workshop was hosted in February. An additional 708 people were reached through our climbing specific REI presentations in Sacramento and the Bay Area.

The MSAC website experienced noticeable growth in the number of users and page visits this season. The number of website users for the

2016-17 winter was 32,782, an increase of 8,138 users, or 33% growth compared to the 2015-16 season. There were 83,829 website sessions this season, and the average session duration was 2 minutes and 13 seconds. Of website visitors, 62% were returning while 38% were new.

The Friends of the Mount Shasta Avalanche Center, created in 2002, is essential to our operations and going strong. The Friends fund the MSAC website and all of our remote weather stations. They organize all fundraising events, including the Backcountry Ascension Race and the Annual Snow Ball party and help with the education and outreach components of the avalanche center. The Shasta Trinity National Forest funded 32% of the MSAC's total operating costs for the 2016-17 season. The MSAC was awarded a CA state OHV grant (other agency cash) that provided 41% of the total cost for this season, and the FMSAC funded 27%. The group represents the soul of adventure and passion for backcountry mountain recreation in the greater Mount Shasta area. We could not do our work without the Friends and local community and extend a huge thank you for all of their effort and support this season.

—Nick Meyers and Andrew Kiefer

SAC

Sierra
Avalanche Center

Atmospheric Rivers and Well Above Average Precipitation

Excitement was high for the winter of 2016-2017 after ISSW in the fall. Staffing remained consistent this year at the Sierra Avalanche Center with returning Director/Lead Forecaster Brandon Schwartz, and Avalanche Forecasters Andy Anderson and Steve Reynaud. Travis Feist and David Reichel continued as professional field observers for the southern portion of the forecast area. Having a dedicated and professional team set the SAC up for success for the demanding winter season of 2016-2017.

Normal Sierra winters have most of the seasonal average precipitation from a handful of atmospheric river (AR) storms—storms that stretch down into the tropics and pull copious amounts of moisture into the west coast of California. This year, depending on how you count them, we had up to 15-20 AR events that impacted our region throughout the fall, winter, and spring. Total seasonal snowpack measurements were around 200% of normal with some areas posting record amounts of total water accumulation.

The winter started early in October with a period of skiable snow for a couple weeks before clear skies and dry weather returned. This early season snow set the stage for the first large avalanche cycle of the year and our first and only avalanche fatality. On December 10, an AR impacted our area with a large loading event and high elevation snow. While rain was mostly falling along the Sierra Crest up to 8000', towards the east in the Mt. Rose area heavy snow was accumulating. Two skiers went into a closed and previously uncontrolled area of the Mt. Rose Ski Resort. As the first skier dropped in, he triggered a wind slab which stepped down to a deep persistent slab ava-

Sierra: Director/Lead forecaster Brandon Schwartz writing the avalanche forecast by candlelight with battery power during an area-wide power outage, Jan. 11, 2017. Photo Jamie Schwartz



lanche failing on basal facets. The slope propagated the entire gully system around 400-500' wide and ran downslope 1000' and buried the skier 10' deep in the runout zone. A ground search with dog teams was initiated, but then was suspended due to increasing avalanche conditions and darkness. Dog teams and probers located the skier the next morning. He was not carrying any avalanche rescue equipment.

Once winter officially began, it was a blur of activity with seldom a time that a storm was not occurring or in the forecast. Large storms caused many road closures, mud slides, power outages, flooding, structural damage, and large avalanche cycles. A series of storms from January 3rd-12th

was one of the noteworthy storm events of the year; it began as a cold storm with low elevation snow then was followed by an extreme atmospheric river event with rain levels up to 9,000'. This storm deposited up to 12" of rain along the Sierra Crest and was followed by another storm with an additional 5-8' of snow. Wind speeds up to 180 mph over the higher peaks and ridges were recorded. This storm system cleaned out the

deep persistent weak layers in the snowpack with evidence of widespread deep slab avalanche activity observed throughout the forecast area. #Januburied became a popular phrase throughout the Sierra Nevada with some locations posting record or near record precipitation and or snow for the month. Large weather systems continued nonstop throughout the winter and spring with impressive snow depths throughout the region.

Over the course of the winter we issued three early season condition updates and 150 daily avalanche advisories. Avalanche advisories included: 1 Extreme, 11 High, 30 Considerable, 85 Moderate, and 23 Low avalanche danger ratings. There were 25 avalanche incidents reported where people were involved, injured, or partially/ fully buried. These incidents included 1 fatality, 2 cars buried on CA Hwy 89 with the occupants successfully rescued and a full burial of a backcountry skier with a live recovery. 47% of the forecast days had avalanches reported. TNF/SAC forecasters and pro observers collected 298 backcountry avalanche and snowpack observations this past season. These were supplemented by an additional 66 backcountry snowpack and avalanche observations submitted by local guide services and 152 observations from the general public.

Our forecast area covers the Sierra Nevada Range of California from Yuba Pass south through the Lake Tahoe Basin, Carson Pass down to Ebbetts Pass, and East to the Mt. Rose area in the Carson Range of Nevada. This includes areas of the Tahoe National Forest, Humboldt-Toiyabe National Forest, Lake Tahoe Basin Management Unit, El Dorado National Forest, and Stanislaus National Forest.

The SAC website was accessed over 1,008,302 times by over 183,533 unique visitors from October 1st through April 23rd. Website traffic increased in page views by 36% and unique visitors by 23%.

200%
of normal

Central Sierra
normal
snowpack

33%

increase in web traffic



Mt. Rose: A large size 3+ avalanche that was triggered with three explosives nearly a half mile up the ridgeline. The crown was around 20 feet at places and old growth trees were pulled out at their roots. Photo Andrew Hennigh

The Sierra Avalanche Center functions as a partnership between the Tahoe National Forest and a volunteer Board of Directors with 501(c)(3) non-profit organization status. This relationship continues to strengthen both operationally and financially while continuing to gain community support. Don Triplat remains as the executive director at his role of fundraising and outreach. The SAC continues to offer community backcountry and snowmobile avalanche awareness. Through the funding from an OHV grant, SAC has developed a snowmobile avalanche education program and were able to run 3 full snowmobile AIARE level 1 avalanche courses this winter. We are fortunate to have a dedicated and talented board of directors that had another record setting fundraising season. The financial support from the non-profit funds the majority of our program. The Tahoe National Forest continues to be a committed partner to the avalanche program and is responsible for the day to day operations of the avalanche center. Together, they have been able to provide a sustainable and expanding organization providing avalanche forecasting and educational outreach to our greater community of the central Sierra Nevada.

—Steve Reynaud

Mt. Rose

Editor's Note: Andrew Hennigh, Avalanche Forecaster at Mt. Rose Ski Area in Nevada, sent TAR this report from the 2017 season at Mt. Rose. We usually focus on summaries from Forest Service Avalanche Centers, but Andrew's tale was so riveting and "extreme" that it deserves to be included in this year's set.

Perhaps I should have written this sooner as I am currently sitting in my favorite little café in Bluff, Utah (the only café in Bluff, Utah) in the middle of July reflecting on this previous winter season. I now have many ranger patrols on the San Juan under my belt and the excitement, agony, joy, and sorrow of this last season has all but washed down river, sort of. I work as the Avalanche Forecaster at Mt. Rose Ski Tahoe on the Nevada side of Lake Tahoe. In case you were inhabiting a cave somewhere this winter I'll fill you in; Lake Tahoe got hammered and Mt. Rose was no exception.

Our grand total for snowfall from the beginning of the water year on October 1, 2016 until closing day on May 29, 2017 was 768 inches of snow and 101.3 inches of Snow Water Equivalent. It was a drought busting season to say the least with 15-20 atmospheric rivers impacting our area according to Steve Reynaud's winter review for the Sierra Avalanche Center. While some of this precipitation came in smaller, somewhat less remarkable storms I want to tell the story of some of the big events because it seemed with each event came some tale of excitement, agony, joy, and/or sorrow.

On October 14th of 2016 the Little Valley fire just east of the Mt. Rose ski area started burning and burned 22 homes before the first of what was to be a long winter of atmospheric river events rolled in on the 16th, giving Mt. Rose 2.8 inches of water according to our Snotel site at 8800 feet. While most of this storm fell in the form of rain we received 11 inches of snow; had temperatures been a little more favorable we likely could have opened our entire mountain with that storm.

Despite a goal of opening the mountain on Halloween weekend, temperatures didn't cooperate and we ultimately opened on November 18th, 2016, on mostly man made snow. Between November 20th to 28th we received 4.2 inches of water and over 24 inches of snow and suddenly we were skiing top to bottom on a few select runs.

Our expert terrain, the Chutes, is 200 acres of "1000+ feet of north facing slopes with pitches from 40-55 degrees!" according to our website. On December 9th, our thirdish atmospheric river came rolling in and by the time it rolled back out on the 16th it dropped 36 inches of snow and 10 inches of water.

All this snow fell on a mixed bag of near surface facets, crusts, and depth hoar. On the morning of December 10th, we received a call from a skier reporting that his friend had been caught in an avalanche in the Chutes. In the early afternoon of December 11th, Search and Rescue teams from the Placer County Avalanche Dogs, Mt. Rose Avalanche

200%-300%
of normal

Eastern Sierra
normal
snowpack



Mt. Rose: Blower operators foiled on the Slide Access Road as old growth trees and a lot of snow broke numerous sheer pins. Photo Dave Hahl

Dogs and Washoe County Hasty found that skier under nearly 10 feet of snow. It was the first and hopefully last fatality in the Chutes since their opening in 2004. It was a somber holiday season, but none-the-less the holidays came and with it the crowds and a few “freshener-upper” storms and on Christmas Day we opened some of the Chutes for the season, although not without some trepidation.

On December 19th, after an extensive round of control work with mainly new snow and wind slabs isolated to the new snow, a single shot placed mid slope in the Charge chute pulled out a large size 3 deep slab. This event led us to keep much of the Chutes terrain closed and had us scratching our heads, furthermore it wouldn't be the last time this dragon came for a visit.

On January 4th I was supposed to start my AIARE Course Leader class in Tahoe, instead I woke up with a nasty case of bronchitis and spent the morning digging the truck out of the 14 inches of snow and 2.5 inches of water we received overnight to drive myself to the hospital. The big one was upon us and by the end of the cycle starting January 2nd and ending the 13th we would pick up over 100 inches of snow and 24.8 inches of water! On that first big morning I was lamenting that the sickness was causing me to miss the biggest storm of my career, ha, little did I know there would be more than enough where that came from. That day while sitting in the hospital I got a text from one of my helper buddies at Mt. Rose that a blower heading up the Slide Bowl access road forgot to close a gate behind him and triggered a small slide that caught three cars, everyone was okay and no damage. At some point during the storm cycle a large size 3 avalanche in the Nightmare chute naturally released and buried that same road with 15 feet of snow and old growth trees resembling a game of pick-up sticks for the gods. It would be well over a week before the access road would be reopened.

The Mt. Rose Highway, the highest year-round pass in the Sierra, was closed for five straight days and with it the ski area which to be honest was a blessing. When the cleanup began we found that a transformer on top of the mountain was pushed off its foundation leaving our patrol shack without power for 38 days. The winter giveth and it taketh away. I could write a thousand words on this one storm cycle alone but alas the season rolls on.

After the dust had settled, but with another large AR on the horizon, it was time to get out and have a look around. The storm had essentially eliminated any persistent instabilities and we were now dealing with avalanche problems customary to the Sierra and Carson mountains: new snow instabilities like wind and storm slabs. On January 19th we had clear skies after receiving a measly nine inches of snow and 1.8 inches of water, however this storm was not accompanied by the stiff southwest wind we're used to. Avalanche activity that day was predictable, long running, 12-inch storm slabs that were easily ski cut or triggered with single explosives. This was great, it was sunny, the skiing was good, and the avalanches manageable. We worked throughout the day on the Chutes in order to open them the next morning. On the last route of the day myself, my assistant, and our assistant director were on a route in an area called Venom Chute. After placing a shot in the start zone that yielded no results, my assistant went in to assess further and immediately triggered a size 2 avalanche that would cause him to pull his airbag and sustain a season ending knee injury. The fact that this area had not avalanched despite all of the results that day should have been our warning, but we were so placated by the easiness of the day compared to the cycle we had just come out of that we had let our guard down in deed. The next day we would go into a cycle that would put down seven inches of water and 32 inches of snow over the course of three days. On the last day of that January cycle, Joe Zuiches, a longtime patroller at nearby Squaw Valley, was killed in a tragic avalanche control accident. The winter that keeps on giving keeps on taking. The snow kept coming, we kept shoveling. Our joke was, “just shoveled the bump shack, better go shovel the bump shack.” There were plenty more stories from the winter that would range from light hearted to frustrating to downright scary, but after Joe's accident the rest of the season's stories were put into perspective.

I have been a patroller for 16 years and an avalanche forecaster for five of those; I'm not sure if I will ever see a season like that one again and I'm honestly not sure I want to. I would love the opportunity to try and do things better in a big season, to not make the same mistakes that seem impossible not to make in a year when there isn't really a chance to recover. I think we do this work for the obvious reasons but I also think we get something from testing our mental and physical fortitude against the elements. This season pushed those boundaries beyond what I believe most people including myself are capable of. I would like the opportunity to do it better if I can. However, despite my own day-to-day struggles throughout the winter a day didn't go by that my soul wasn't filled with awe and gratitude for what the mountains are capable of.

—Andrew Hennigh

ESAC

Eastern Sierra Avalanche Center

Weather & Snowpack

After a welcomed uptick in snowfall from the much-hyped but unremarkable 2015/16 El Niño, coupled with a number of intense October storms, the eastern Sierra backcountry community was well primed for a promising 2016/17 winter season. Winter did not disappoint as the season unfolded; precipitation totals throughout the Sierra were well in excess of normal by season's end, with many sites breaking decades-old records. Despite the frequent storm/avalanche cycles and exceptional seasonal snowfall, including some notable rain or rain on snow at the low elevations, there were no fatalities recorded in California this season. However, the incredible snowfall totals came with a price for many eastern Sierra communities as more than a few buildings suffered under the weight of the immense snowload. One multi-family structure sustained a mostly direct hit by a large fast moving avalanche from Mt. McGee (1/22/17). The occupants were not injured but the building sustained extensive damage, requiring a prolonged relocation of the occupants.

The previous winter's overly-hyped El Niño was no match for the winter of 2016/17 in California. With the NOAA forecasting a weak La Niña and most indices leaning toward “normal to near normal” precipitation, the winter should have been average at best but it turned out to be anything but normal. Throughout the winter, atmospheric rivers (AR) fed warm moist air into the frequent storms spinning off the seasonal Aleutian low, providing additional moisture while enhancing the storm's energy and winds. The combination of a weak La Niña and a slightly positive arctic oscillation may have been the key to opening the door for atmospheric rivers to play a larger role throughout winter.

The 2016-17 winter began in October as two strong AR enhanced systems rolled through the region with up to six inches of precipitation re-

Eastern Sierra: McGee House in the McGee slide, side door to garage, door to kitchen. Photo Josh Feinberg



Mt. Rose Ski Area: 768 inches of snow (0.25 mm = 1 in)

Mammoth Mountain Ski Area: 621.5 inches of snow (0.25 mm = 1 in)

ported in the higher elevations (Mammoth Ski Area, elev. 9,014' - 9.55" snow, 2.55" water), with snow confined to the northerly aspects in the alpine and sub-alpine, and punctuated by cool dry spells. November's weather continued the cool dry cycle with only a single storm system with modest accumulations reported (Mammoth Ski Area 12.0" snow, 1.44" water). The seasonably cool temperatures and limited precipitation helped to drive facet formation between rain crusts which had formed in the alpine and sub-alpine terrain during the previous months. December saw a couple of AR waves move through the region mid-month depositing a total 68.5" at Mammoth Ski Area by month's end. January saw a series of nearly continuous storms roll through the Sierra with at least five ARs impacting the region. Mammoth Ski Area recorded a whopping 245" for the month with similar amounts recorded throughout region. During February, the extreme weather continued with at least three strong ARs impacting the region, resulting in precipitation and snow accumulations exceeding seasonal averages by the middle of the month with Mammoth Ski Area recording 170" for Feb. March saw the AR pattern weaken with three more modest storms depositing only 38.5" at Mammoth Ski Area. By April, a shift toward a more typical spring weather pattern was well under way, which is characterized by fast moving storms and limited snow accumulation. Mammoth Ski Area recorded 68.5" for the month. May saw little snow (Mammoth Ski Area - 8" snow, 1.59" water) and also saw temperatures climb into above normal territory and the mid and low elevation snowpack quickly receding under the intense spring sun. A total of at least 15 Atmospheric Rivers impacted the region through February with ~23 by season's end, the average is seven to nine AR events per year for the Sierra. By season's end, most weather data sites were reporting 200% to 300% of normal, breaking many decades long records.

Mammoth Ski Area season total - 621.5", (record 661.5", 2010-2011), 87.03" water (previous record 78.41", 2010-2011).

Avalanche cycles were well timed with the AR-enhanced strong storm cycles moving through the region from mid-December through February with some storm's cycles lasting for several days with a brief respite between systems. The frequent and intense mid-winter storms kept avalanche hazard at considerable to high during storm cycles with the exception of the 1/21/17 cycle where conditions bumped up to extreme with extensive natural avalanching reported throughout the region including the slide from Mt. McGee that struck the multi-family home mentioned previously. Generally, as the weather cleared after each storm, stability generally improved over the course of a few days with the hazard falling back to moderate or low.

The basal facets that formed during the fall were responsible for a number of large full-depth avalanches from mid-December through January. By the end of January most of the basal instabilities had either avalanched, strengthened over time, or were deeply buried and bridged over by the overlying snowpack. Thereafter, the primary avalanche hazards were related to mid to upper snowpack instabilities associated with new snow and wind transport, which continued through the remainder of the season. These mid and upper snowpack instabilities were relatively numerous and occasional-



Eastern Sierra: Pine Creek north of Bishop, California. Debris flow channel. Avalanches originated above 12,000', debris 7,000'. Photo Howie Schwartz

ly produced large destructive areas throughout the backcountry. As March unfolded, AR-enhanced precipitation declined while temperatures climbed, producing an extended spring wet cycle through much of the month. April saw a few fast moving storms with quickly stabilizing surface instabilities then transitioning into wet slide cycle as temperatures climbed into seasonal and above. May temperatures were seasonal to above with minimal precipitation with the standard wet spring surface releases, and the occasional glide slide.

ESAC

The 2016/17 season marked ESAC's eleventh season of operation serving the eastern Sierra backcountry community and its second season as an independent non-profit avalanche center. This season, the Center moved aggressively to achieve its long-term goal of becoming a Type I center by hiring a third forecaster, adopting Avalanche Advisory formatting, and increasing the weekly publishing cycle from three to five with the long-term objective of moving to a full seven-day schedule.

Historically, ESAC has operated with the assistance of the Friends of the Eastern Sierra Avalanche Center (FOESAC). FOESAC was formed to provide support to ESAC's fund-raising events and membership drives. In 2015, the FOESAC's board of directors elected to adopt an independent model for the Center to allow greater operational flexibility to meet community needs.

FOESAC continues its critical role in support of the ESAC through community fund raising and local sponsorships plus grants applications and fostering inter-agency support, while providing direction and leadership. Their efforts are critical to the operation of the Center and have led to increased staffing and expanded coverage, incorporation of new web enhancements and social media platforms, and helping adapt to changing community needs.

Forecasters Doug Lewis (Lead) and Josh Feinberg returned for the 2016-2017 season. Clancy Nelson was hired as the third forecaster in mid-February.

The ESAC website saw the addition of mobile friendly improvements, a switch from Snowpack

Summaries to Avalanche Advisory format, and enhanced regional and real-time weather products. Additionally, the Center incorporated the Mountain Hub's observation platform into the website, while Rakkup teamed up with ESAC and introduced their Eastern Sierra Guide App with route descriptions and maps of the region. The website enhancements are intended to supply field usable tools for reporting and obtaining the snow/avalanche conditions.

During the 2016/17 season, the Center continued its snow safety outreach and educational offerings with several public events this season, including public avalanche awareness clinics, ESAC observer network training, Snow School (middle-school winter environmental awareness program), Mountain Adventure Seminars, and a two-day clinic with Mono County Search and Rescue. All the clinics were exceptionally well attended and encouraged participants to seek additional training opportunities.

ESAC covers an area nearly 180 square miles that extends from Virginia Lakes to Aspendell. Collecting snow and avalanche data from the four main watersheds is a massive undertaking with the Center's limited staff. To remedy this situation, ESAC utilizes a community observer network to augment staff observations. ESAC sponsored an evening clinic and a field training session in January for interested members of the backcountry community willing submit snow and avalanche observations. The clinic focused on familiarizing people to the observer network, highlighting important field data, and introducing the submission process. Nearly 30 people attended the evening clinic, 12 people participated in the field session. The observer network posted 180 snowpack and avalanche observations on the website from Nov. 30, 2016 through June 17th, 2017, a 330% increase over 2015-16.

Season Highlights

- Hired a third avalanche forecaster (Clancy Nelson) in mid-February to expand coverage and increase number of weekly advisories issued.
- A total of 97 Snowpack Summaries

(12/2/16 -2/11/17) and Avalanche Advisories (2/13/17 - 5/30/17).

- ESAC website usage increased 25.68% over last year with 92,169 user sessions between Oct 1, 2016 - Jun 3, 2017 compared to previous season's 73,336.
- ESAC community-based observer network (augmented field observations) submitted 180 snowpack and avalanche observations, 330% increase over last season.
- ESAC snow safety and community outreach included: three avalanche awareness clinics, support for the Winter Wildlands Alliance's Snow School, Mono Country Search and Rescue trainings, and support for Mountain Adventure Seminars.

—Doug Lewis

WAC

Wallowa Avalanche Center

The winter of 2016-2017 can be summarized by colder than average temperatures and above average snowfall down to the valley floor. Winter didn't fully kick into gear until January, when snow totals began to rise to slightly below average. By the end of April, the snowpack stood at 120% of normal in the Wallowa Mountains. January saw some very cold days, well below average for our area and the limited days of high pressure resulted in a relatively stable snowpack throughout the season. Two big warm up events, occurring around the 9th of February and the 10th-15th of March resulted in the largest natural avalanche cycles of the season. Both of these were rain-on-snow events and large cornice collapses; predominately in the Northern Wallowas triggered numerous size 3 avalanches.

After the unfortunate passing of Kip Rand, (former WAC director) Victor McNeil took over as Executive Director for the 2016-2017 season. McNeil has been ski guiding in the Wallowas for the past seven winters and has been providing professional observations to the WAC for the past three seasons.

Over the course of the winter the WAC issued 20 advisories on a weekly basis. These advisories, delivered each Thursday, are a summary of the past week, and a forecast for the coming week. The advisory includes visual icons for the top two avalanche problems, a bottom line, current conditions, a greater explanation of the avalanche problems

Wallowa: Wet slab that released around the March 15th warm up and traveled down Jim Fiske Creek in the Southern Wallowas. Photo Ben Woodcock



Northwest: A cornice collapse on Ptarmigan Ridge near Mt. Baker on April 21st. Photo Lee Lazzara

120%

Wallowa
normal
snowpack

and a short video. Throughout the week updates in snowpack stability and trends were broadcast on Facebook and Instagram. Three Avalanche Warnings were issued over the course of the winter, the first being February 9th, which was the largest natural avalanche cycle of the season. The National Weather Service in Pendleton works with the WAC to disseminate our warnings through the NWS channels.

The WAC provided numerous educational opportunities for the local communities, mainly through Avalanche Awareness Presentations given by Michael Hatch. Hatch runs the Outdoor Program at Eastern Oregon University and also contributes to the weekly avalanche advisory throughout the winter.

A winter highlight was the Eastern Oregon Backcountry Festival held in late January as a three-day event. Night one was a series of films by the Winter Wildlands Alliance, with a live auction and raffle. Day two was at Anthony Lakes ski area, which started out with the Kip Rand Memorial Uphill/Downhill race. Thanks to Anthony Lakes ski area for awarding the fastest male/female competitors with a free season pass. In the afternoon Michael Hatch led a companion rescue and snowpack assessment clinic, free to anyone interested. The fun continued into the evening, with live music at the famed Star Bottle saloon and a pair of Black Diamond skis were raffled. The final day was an opportunity for folks to go out into the nearby backcountry for a ski tour. This event was a huge success and raised significant money and awareness for the WAC.

As the great winter of 2016-17 comes to an end the WAC is already looking forward to next winter. We received great support from our local community and visiting skiers and other winter recreationalists this past winter. With our fundraising efforts this winter and generous donations we're hoping to offer better resources for locals and visitors to our local mountains next winter. Thanks to everyone for the continued support and shared vision in keeping winter recreationalists safe and informed in the mountains of NE Oregon.

—WAC Staff

NWAC

Northwest Avalanche Center

Question: How can three guys run a successful avalanche center, issuing mountain weather and avalanche forecasts several times a day, keep a heap of weather station data flowing, throughout a long and active winter season?

Answer: They can't! Well, not alone they can't.

The necessary support to our forecasting program comes from near and far, from within and without, to produce the best products and services to the winter recreating public and our professional partners. Daily support comes from our invaluable dialogue with ski area and WSDOT forecasters, the dedicated team of NWAC observers and the increasingly helpful observations from the talented recreating public, to name just a few.

Our long anticipated hiring of a fourth forecaster, Robert Hahn, to help share the workload this season was affected by a matter of bad timing as the official hiring offer was subjected to a federal hiring freeze that went into effect just one day prior! So close, but still so far. Fortunately for the NWAC, Robert volunteered, nearly full time for the majority of the winter until he was hired in April. See announcement on page 7.

NWAC staff will spend time over the summer to implement needed project efficiencies and work to improve and streamline our forecast products. We also hope to add Avalanche Specialist forecasters for the coming season.

Winter Review

The winter of 2016-2017 was a long busy winter with a lot of significant rain, snow, and avalanche events.

November was notable for heavy rain and then wet snow. Mt Baker had about 30 inches of water equivalent mostly as rain in November.

Snow began accumulating in earnest in December. A particularly heavy period came December 1 to 6 when several NWAC stations had 40-50 inches. The first fatality of the season came at White Pass on December 27 when a solo skier triggered and was subsequently killed in a soft slab avalanche about one mile west of the White Pass ski area.

January had some dry periods along with an atmospheric river event on January 18. Strong east winds caused wind slab and a fatality (another solo skier outside resort boundaries) at Crystal Mountain on January 4.

More heavy snow was seen in early February; some NWAC stations had over 50 inches from February 3 to 6. A major warm front and avalanches on February 8 and 9 simultaneously closed Highway 542 and Stevens, Snoqualmie, and White Passes. An atmospheric river arrived on February 15 with avalanches seen to low elevations along the Cascade east slopes including Tumwater Canyon.

More snowy weather came in late February and early March. Mt Baker had 117 inches from March 1 to 9. March 5 was a particularly hectic day of avalanches with a fatality at Hawkins Mountain. Two snowmobilers were caught and carried in an avalanche in a SE-facing bowl on Hawkins Mountain after one snowmobiler in the party high-marked near the top of the bowl and triggered the slide. A separate party of two resting in the run-out below was able to escape on foot but their sleds were caught and buried. Regarding the two snowmobilers caught, one was partially buried (critical) with only his hand sticking out (enabling rescue) and the other was a complete burial who died. Additional snowmobile parties arrived on scene to aid in the recovery effort. The victim was located and extricated after 40 minutes.

Further warm, wet or snowy storms were seen through the end of March.

A cool extended winter with more than usual snow at higher elevations was seen in April and even May. A fatality occurred on Red Mountain at Snoqualmie Pass on April 11, another solo skier who was traveling with his skis on his pack and triggered an isolated pocket of wind slab on the ascent.

Air Sciences Graphs

This February we were excited to roll-out our new weather station graphs. Parsing through our network of 40+ stations can be a bit tedious and overwhelming. To help with this, NWAC teamed up with a Portland-based company, Air Sciences Inc, to build customized weather station graphs for each avalanche forecast zone. NWAC forecasters start each tool with the best and most reliable stations for winds, precipitation, and temperatures. For most users, these pre-loaded graphs will contain all of the information you need to plan your day. The data visualizations were built primarily using the Data Driven Documents (d3) JavaScript library (d3js.org).

The most powerful and unique aspect of our graphs is the ability to mix and match any weather station within NWAC's network without leaving the page. You can remove and add new parameters and re-order the graphs to build a custom plot to answer your specific question. All of this is done using the buttons to the right of each plot.

Features include:

- Each station graph starts by showing you the latest five days. If you wish to look back further, simply scroll or zoom out using your mouse scroll wheel or fingers on the touchscreen. Currently, station data is viewable back to 2014.
- Cursor position will be linked with a vertical line through all graphs and displaying each value and observation time



- Users will be able to bookmark a customized plot
- Option for graphs to update automatically (check box at the bottom of the graph will refresh your browser every five minutes)
- Legacy graphs are still available
- Visit the Observations tab of our web site to completely check out the new Air Sciences graphs.

—Kenny Kramer – Director,
Garth Ferber, Dennis D’Amico,
Robert Hahn – Forecasters

IPAC Idaho Panhandle Avalanche Center

Weather and Snowpack

The winter started by La Niña escorting in light snow and colder-than-average temperatures for northern Idaho. Most of the early season storms tracked out of southern BC and started us off with a continental-style snowpack. Just like most continental snowpacks, the chief complaint early season was basal instability.

No big deal... After 20 years of digging in central CO, continental snowpack makes sense to me. It's like that every year here, right? Nope—not in North Idaho!

Idaho Panhandle: An April 13th wet slide after 5" of snow followed by 1.2" of rain. The avalanche was moving like lava as it flowed down this 20-25 degree slope. Photo Jeff Thompson



In October, I started my new job with the Idaho Panhandle Avalanche center as the center's Director. With so much new (duties/terrain/forecast area) to figure out with the new job, at least the snowpack was making sense to me. It's sort of funny to think of a touchy, PWL laced, faceted snowpack as my comfort zone – but it was, it's what I know inside and out. I think Mother Nature was being kind to me by starting out with a snowpack that I've come to understand...her generosity was, of course, short-lived.

Just after the New Year arrived, La Niña quickly neutralized and warmer, wetter weather moved in. That early season basal facet avalanche problem? It quickly disappeared. It was interesting to see how the weak basal facets could so quickly turn into strong, rounded, wet grains in a matter of day and be replaced overnight by storm slab and wet snow avalanche problems. In early to mid-January, the snowpack in the Idaho panhandle was hovering around 69% of average – and with the arrival of bigger snow systems in February, the snowpack recovered to about 89% of average, and 99% by mid-April.

Forecast

Although there were numerous avalanche incidents adjacent to our forecast area, we did not have one reported human triggered avalanche fatality or accident in our forecast region – despite four periods of High danger.

This was an especially productive season for our forecast. One of our most-anticipated accomplishments was the launch of our new website, with the help of Sierra Avalanche Center forecaster/cyber-guru Andy Anderson. The new site is more consistent with what other Forest Service Avalanche Centers are doing, and we think the many compliments we've gotten on the look and information delivery methods are well deserved! We're excited to have it up and running, and look forward to utilizing all the options it has in

the future. If you haven't seen it, check it out at www.idahopanhandleavalanche.org.

Another improvement to information sharing this season has been the addition of a Tuesday forecast. Prior to this season, IPAC produced only a weekly Friday forecast, but we upped that to twice a week with our increased resources.

In addition to our new website, one of our best outreach avenues is social media. We were constantly posting avalanche information to Facebook, as well as two weekly videos. The videos have proved to be very popular, sometimes logging more than 2000 views (that's a lot for us!).

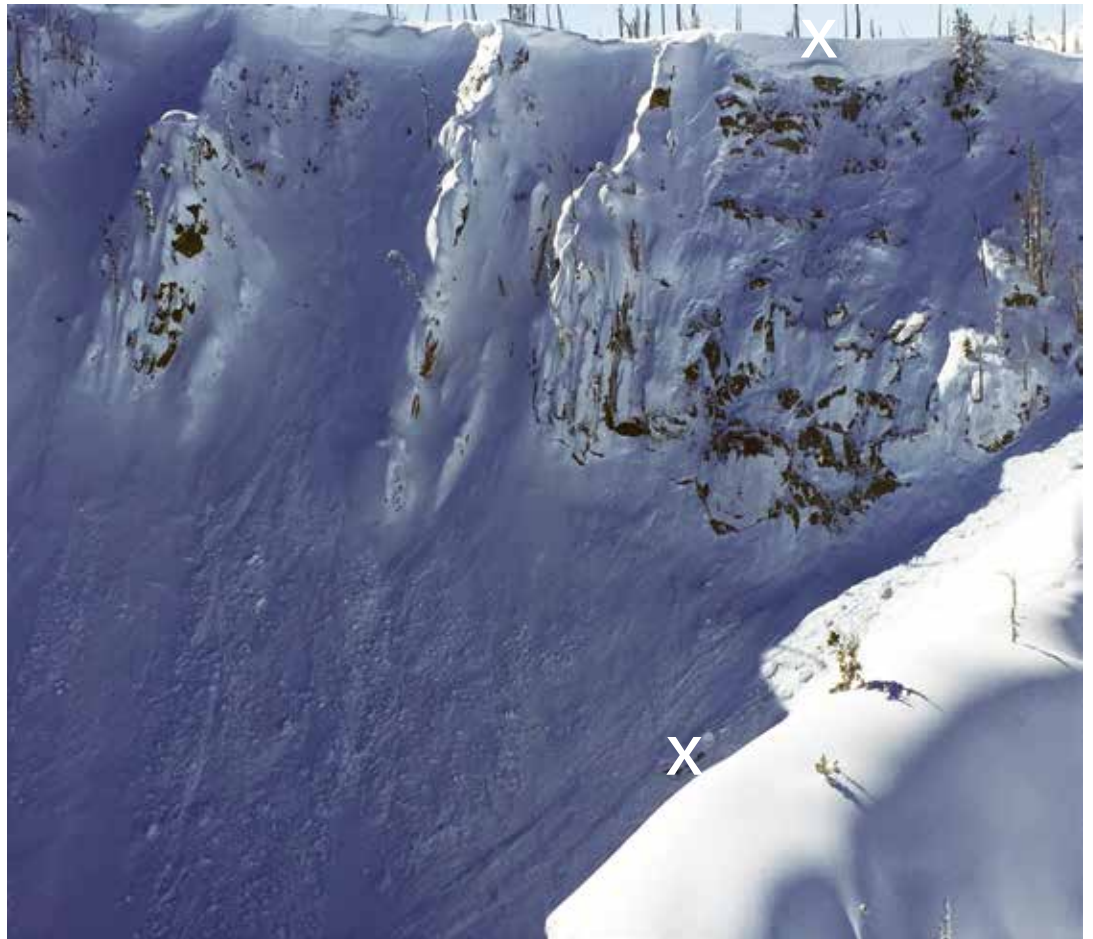
Education and Outreach

IPAC also had a very productive season for avalanche education. We taught a wide variety of avalanche classes, from 'Know Before You Go' for local schools to Avalanche Awareness for the U.S. Border Patrol to AAA Avalanche Level 1s, and more.

We had a total of 1,014 students in 39 different classes go through various levels of avalanche education with IPAC this season. We're excited to build on the success of this year's educational outreaches with additional opportunities next season. We're not quite ready to reveal our new products yet, but stay tuned to our website for more information, especially as we get closer to fall: www.idahopanhandleavalanche.org.

Additional Highlights

- Thank you to our Forecaster Dan Friegard for his years of Service to IPAC. Dan retired from the Forest Service in December and left some big shoes to fill, but is still volunteering his time teaching avalanche classes. Thank you for everything you've done to help get IPAC to be the organization it is today, Dan!
- This was the first season in IPAC's history that we had the resources to hire a full-time Executive Director. Jeff Thompson started in October 2016, and deftly took the reins of a quickly growing Avalanche Center. Jeff came to us with 20+ years of ski patrolling, forecasting, and avalanche education instructing.
- IPAC was happy to add Melissa Hendrickson to our crew of forecasters. Melissa has been a great addition to our team, and helped fill the hole with Dan retiring. We're glad to have you on the team, Melissa!
- We purchased jackets for our forecasters to highlight our IPAC "brand" to make us more recognizable to the public, and to give a truly professional appearance to videos, in-person encounters, etc. We're happy with the new professional look!



Payette: Cornice was reported to be 10-15 feet out from where the snowmobiler was standing (upper X) and he came to rest and was buried up to his chest below (lower X). Slab avalanche was triggered below cornice and continued out of the picture to the looker's right. Photo Kent May

- We continued the Doug Abromeit Memorial Scholarship this year, and had a record number of applications! After reviewing all of the entries, we awarded the scholarship to Hunter Hyde, and sent him to a three-day American Avalanche Association Level 1 avalanche course through the Abromeit Scholarship.
- Our forecaster Kevin Davis obtained his American Avalanche Association Instructor certification. It's a great certification for a forecaster to have, and a direct reflection on Kevin's knowledgeable teaching ability. Nice job, Kevin!
- Our Friends of IPAC President, Scott Rulander, finalized our operational video: a six-minute video designed to capture who we are, what we do, and how we do it here at IPAC. Scott produced a high quality video, and we're excited to have such a terrific showcase of what we do.
- Forecaster Eric Morgan and Director Jeff Thompson attended a meeting in McCall, ID with the other two avalanche centers of Idaho. During our full-day session, we covered industry standards and forecasting techniques, and were glad for the opportunity to meet and share knowledge with our fellow Idaho forecasters.
- The National Weather Service has been helpful with relaying our message during high avalanche danger periods. When we issue an Avalanche Bulletin, NWS posts it on their website for exposure to as wide of an audience as possible.
- Schweitzer Ski Patrol and Silver Mountain Ski Patrol have been a great partners to IPAC. Their Snow Safety teams consistently submits quality avalanche observations to IPAC. Tom Eddy, Snow Safety Director,

deserves special thanks for posting daily on our Facebook site with what he's seeing regarding weather and avalanche conditions.

—Jeff Thompson

PAC

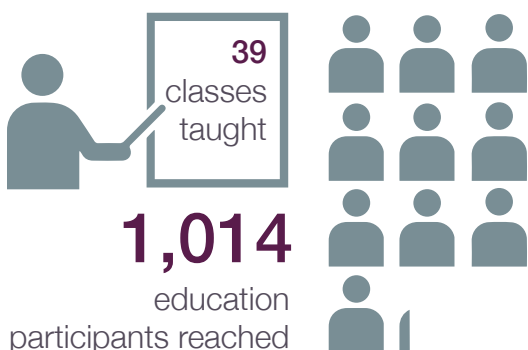
Payette Avalanche Center

"I can't keep a-arms in stock. I've replaced two for one guy...this week...on the same sled" our local snowmobile mechanic K.C. told us on a trip to his shop in mid-December.

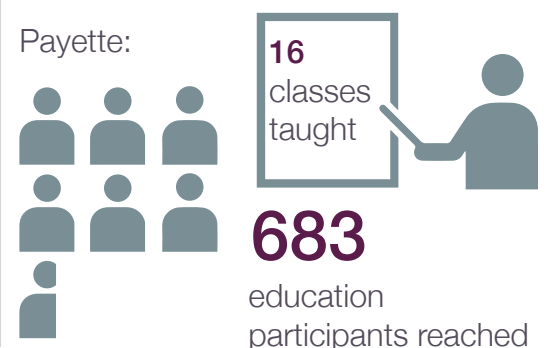
A long warm fall, and a ridge of high pressure had everyone (that has interest in sliding on snow) a little antsy into, and through most of November. The week of Thanksgiving the snow finally started to fall. It slowly added up and had the density of champagne powder. The cold temperatures and low density snow continued until December 9th when the West Central Mountains got a much needed storm cycle and heavy snow and wind that aided in the covering of a-arm busting logs, stumps, and rocks and in turn resulted in the first avalanche advisory of the 2016-2017 season on December 15th.

Weekly storms of modest amounts slowly added to our snowpack, and everything seemed to be going well. Local Snotel stations recorded mod-

Idaho Panhandle:



Payette:



est amounts of SWE through January, no huge storms just consistent small storms to keep the backcountry freshly covered and the local ski hills happy. That is until the first week of February when the PAC advisory area received 5.3 inches of SWE in 9 days (Brundage Reservoir). Unfortunately this onslaught of moisture was accompanied by temperatures hovering around freezing at middle elevations. In total February had a total of 10.2 inches of SWE, resulting in only 36 inches of snow at the Brundage Reservoir Snotel at 6,250 feet but 75 inches of snow at 7,600 feet (Brundage Mountain).

March provide to be a wet one as well. 7.5 inches of SWE (Brundage Reservoir) kept the West Central Mountains under a veil of clouds for much of the month, and much like February, temperatures trended above average. In total McCall had only 5 days where the sun made an unobstructed appearance in the month of March.

Avalanches:

The warm and wet storm from the beginning of February caused a wide spread avalanche cycle due to rain falling on snow to the highest peaks around the PAC advisory area. This storm cycle also caused for massive cornice growth, and a subsequent cornice fall avalanche cycle. One of the cornice fall avalanches was unfortunately human triggered. The individual, the cornice, and a slab avalanche (triggered from the cornice fall) all came cascading down a ~200 foot cliff. Luckily he was only buried up to his chest, as he was not wearing an avalanche transceiver. Due to the lack of a safe access route or a suitable landing zone, local SAR resources and a Life Flight helicopter were unable reach him. Two Bear Air Rescue out of Whitefish, Montana was dispatched. Two Bear used the hoist on the Bell 429 helicopter to extract the injured snowmobiler. A video of the rescue can be found on the Two Bear Air Rescue website (<http://www.twobearair.org/videos2/>) and gives a great view of the accident site.

Education:

- 2016-2017 was a record breaker for the PAC. We taught 19 classes total to 683 individuals.
- Second annual avalanche rescue class for McCall Fire and Rescue.
- Annual 'Women's Only' class was once again at max capacity.
- Continue to find/look for ways to engage snowmobile/snow bike community more in forecast center and education.

Highlights:

- 2010 snowmobiles with over 8,000 miles spent more time in the shop than on the snow.
- Idaho Parks and Recreation Grant of \$25,000 paid for a third avalanche specialist for the second year in a row.
- 102 daily advisories issued.
- 7 days of HIGH danger rating.

—Kent May

SAC Sawtooth Avalanche Center

"United States forecasters are generally more likely to assign lower danger ratings and are less likely to use a rating of EXTREME than their commonwealth counterparts."



Sawtooth: Deep persistent slab avalanche on Boulder Peak in the Boulder Mountains of Central Idaho. This avalanche was an estimated 10' deep and ran nearly 4,000 vertical feet to the valley bottom. Photo VandenBos

This finding came from Brian Lazar and his co-authors' eye-opening ISSW presentation last fall. Coincidentally, their paper was an interesting prelude to a winter where some avalanche forecast centers—including the Sawtooth Avalanche Center (SAC)—issued EXTREME danger ratings for the first time in their history. The winter of 2016-2017 will be remembered for record-breaking precipitation, snowfall, and avalanches that kept everyone busy - city managers, snow removers, and avalanche forecasters alike.

Mid-October snows brought the powder hungry out to Galena Pass following a quick hitting storm that would come back to haunt us in December. After a few days of decent early season turns, "anything but powder skiing" would aptly describe the November snow conditions. High pressure, warm weather, cold weather, a few small storms, impressive faceting, and a rock hard frozen rain layer created an interesting snowpack by early December; we were primed for dangerous avalanche conditions once the jet stream returned to Idaho. On December 9th, we issued our first advisory for the season. Over the next nine days, the snowpack would transform from a shallow, early-season blanket to a loaded gun. During this stretch, area weather stations recorded 40-50" of snow and 4-6" of snow water equivalent (SWE), prompting four days of HIGH danger and the first EXTREME danger rating in SAC history. Widespread avalanching occurred on all aspects and at all elevations, including a rain-on-snow induced cycle which struck homes in Hailey, blocked the Big Wood River in several locations, cleared new trim lines, and caused flooding in residential neighborhoods (video here: <https://goo.gl/qByriv>). When the skies cleared, we observed large crowns throughout the advisory area. A deep persistent slab avalanche on Boulder Peak was estimated to fail up to 10' deep and ran nearly 4,000 vertical feet to the valley floor.

January and February broke snowfall and precipitation records across Idaho. Many places in our advisory area received greater than 200" of snow and 30" of SWE. The month of February really brought us into another realm with 380-440% of our 30-year average precipitation. While wind slabs remained the primary concern at up-

per elevations, a series of rain events produced wet avalanche cycles that again threatened towns and prompted evacuations in the Wood River Valley (video here: <https://goo.gl/GcXMHJ>). Our longest and heaviest widespread precipitation event of the season dropped at least 60-80" of snow and 7-11" of SWE in eleven days, prompting four days of HIGH danger and the season's second day of EXTREME avalanche danger. Wetter portions of the advisory area received over 18" of SWE in the first 22 days of February. As skies cleared, the extent of the avalanche cycle(s) (or what we could see that hadn't been reburied) was stunning. From one vantage point, we gazed at dozens of



1,500' wide crowns. A single event a couple miles north of Ketchum spanned a large cirque and approached a mile wide.

Lazar's paper indicates a hesitation for US forecasters to use LOW and EXTREME danger ratings. Discussions at the 2016 fall USFS National Avalanche Center meeting and at ISSW 2016 continued once at home in Idaho. We further explored this topic within the SAC and at the first-ever meeting of all three Idaho avalanche centers in McCall, ID. Were we more willing to entertain an EXTREME danger rating this year? Or did this year simply provide the setup that would have brought us to the same conclusion had it occurred last year? At the Gallatin National Forest Avalanche Center's (GNFAC) Professional Development Workshop for Avalanche Professionals, I had the opportunity to hear about the EXTREME danger ratings issued by the Crested Butte Avalanche Center and GNFAC. They shared the build-up, indicators, media hype, and aftermath of each cycle. EXTREME danger is something that few of us have ever issued, and with it comes critical hindsight. Did it verify? This question is perhaps not as important as "was this a good forecast". Meaning, given the information I had in the "hot seat" that morning, would I come to the same conclusion again? Did I miss anything? In my opinion, Lazar's paper sparked crit-

ical, pre-season dialogue that eased the decision to forecast EXTREME danger when we saw it. Will we see more EXTREME danger ratings in the next five years than in the last five years? My guess is yes, and it won't require record snowfall.

—Scott Savage

WCMAC West Central Montana Avalanche Center

This season was marked by transition. Director Steve Karkanen and Specialist Dudley Improta both retired from the center. I moved into the leadership position of the center as Lead Avalanche Specialist and Logan King moved into the role of Avalanche Specialist. Tim Laroche and Greg Anderson from the Lolo National Forest helped with gathering snowpack observations. Ed Snook, David Fox, and Geoff Fast from the Bitterroot National Forest also provided observations. Ryan Milling, Josh Tapp, and Matt Radlowski from the WCMAC also gathered snowpack data this year.

This season's snowpack was 108 percent of average. We issued a total of 60 advisories over the season, including six Avalanche Warnings. This is the most danger ratings issued in the center's history which would be considered an extreme, although the snowpack was never rated extreme. Of note the series of atmospheric rivers created rain-on-snow events at higher elevations and earlier in the season than typically seen for the region. For our advisory area there were only a few close calls and no fatalities this season. There were also multiple close calls reported from outside our advisory area in ranges not covered by avalanche centers.

Josh Tapp took on the role of Avalanche Education Coordinator. Matt Radlowski and Ryan Milling moved into avalanche educator positions. This team was able to reach 1,813 participants. The classes offered this season ranged from our school program, avalanche awareness presentations, mountain weather and level one courses. The numbers reached this season are a slight increase from last season. The education team with Josh at the helm looks forward to increasing the number of courses offered, while adding new courses and ultimately reaching and better serving the community next season.

Our Friends group did a stellar job supporting the Center with board president Spencer Bradford leading the charge. The board hired Patrick Black as the Operations Coordinator. The number of visits to our website and all other social media platforms increased 10 percent from last season. The Center would not be here without the hard work of the board.

All personnel are coming back next season and are looking forward to another season serving the needs of winter users in our advisory area.

—Travis Craft

West Central Montana:



education participants reached



Flathead: A large avalanche on Heavens Peak during a late season storm. Crown depth estimated at 3-6 feet. Photo GTSR Avalanche Program

FAC Flathead Avalanche Center

Yes, the Flathead Avalanche Center issued its first ever Extreme danger rating on February 6, 2017 due to over 5 inches of SWE and 60 inches of snow with strong to extreme winds in three days. However, a more extraordinary event was the much anticipated arrival of the new center director, Zach "Wait...It rains here?" Guy. Zach left his self-proclaimed center of the universe, Crested Butte, and arrived to the unfettered mountains of northwest Montana in April. While initially dismayed at the thought of skiing a relatively consistently stable snowpack without depth hoar, he managed to intentionally trigger a sizable avalanche in Glacier National Park on his third day out. His response: "Well, it certainly went larger than expected." Welcome, Zach. We are glad to have you on board.

1st ever  EXTREME

Before Zach arrived, the FAC put on a great display of teamwork. Erich Peitzsch, former director, left the hallowed halls of directing an avalanche center for even darker pastures (is that possible?), pursuing a Ph.D. as he continues to work for the U.S. Geological Survey. The indefatigable Todd Hannan rose to the occasion to step in as Interim Director for the season. Under his direction, the center issued 125 avalanche advisories, nine pre-season information updates, and two post-season information updates. Todd and Mark Dundas served as full-time avalanche specialists while Seth Carbonari, Adam Clark (USGS), and Erich filled in together as the third avalanche specialist. Guy Zoellner worked as a snowmobile observer and provided valuable field data to the team.

It truly was a season of extremes as an early tragedy close to home shadowed the entire winter. On January 5, a beloved community mem-

ber, friend to us at FAC, and board member of the Friends of the Flathead Avalanche Center (FOFAC), Ben Parsons, triggered an avalanche on Stanton Mountain in Glacier National Park, and subsequently died of traumatic injuries. We are deeply saddened by this tragedy as Ben was a great friend to many, traveled many miles in the backcountry with us, and had a deep love for the mountains. We offer our sincere condolences to Ben's family and other friends. We will fondly remember Ben's infectious approach to playing in the mountains, and appreciate his time spent helping the Friends of the Flathead Avalanche Center as a board member. #BennyUp.

This tragedy rocked the FAC, but the team was able to persevere and provide quality products to the community. January and February were characterized by well-below normal temperatures (-5° to -11° F below average) due to cold air masses infiltrating from the north. Snowpack depth hovered below average (65%-85% of average) until February arrived. Consistent and abundant snowfall this month created smiles on snowmobilers and skiers' faces as well as large and widespread avalanche cycles. From February 4-9, a series of storms deposited nearly 8 inches of SWE and over 80 inches of snow over the advisory area. The widespread activity throughout the advisory area was impressive. Large debris piles littered nearly every basin, and riding around after the storm ceased was a forecaster's dream. At the beginning of the storm, a very close-call involving five snowmobilers (1 partial burial and 1 full burial)

Flathead:



education participants reached

occurred in the Swan Range. Fortunately, no-one was injured, and they were able to make it out on foot with some assistance from Flathead Country SAR. The rest of the season saw the typical wet snow avalanche cycle in March due to rain-on-snow, and then a wet slab and glide avalanche cycle in later April due to abundant sunshine and warm air temperature.

The Friends of the Flathead Avalanche Center continued to make great strides in fundraising and education. The Northern Rockies Snow and Avalanche Workshop kicked off the season in early November with fantastic presentations and a great raffle. Jenny Cloutier, FOFAC's enthusiastic education coordinator, worked incredibly hard to organize FAC education efforts, and helped teach over 1600 students of all ages throughout Northwest Montana. The education effort, led by Jenny, was also a team effort consisting of forecasters, FOFAC members, and experienced community members. We appreciate the dedication, time, and energy that FOFAC puts forth into supporting FAC. We look forward to keeping the momentum going and continuing to grow FAC into the future under Zach's leadership.

—Erich Peitzsch

GNFAC **Gallatin National Forest Avalanche Center**

It was another busy season for the GNFAC as Doug, Eric and Alex issued 138 daily advisories resulting in more than 230,000 visits to the website. The average duration of each visit was nearly two minutes. The GNFAC also made 79 videos over the course of the winter receiving more than 150,000 views on Youtube. The Friends of the GNFAC taught 117 avalanche education classes to over 5,000 people, a new record. The GNFAC also did over 30 interviews with various media outlets around the Bozeman area.

Winter in southwest Montana began with snow in early October. By November 1st, the mountains south of Bozeman and mountains near Cooke City had 2-3 feet of snow on the ground with no more than a foot elsewhere. This snow turned into a melt-freeze crust and cold temperatures allowed it to persist on shady, high elevation slopes.

In late November, 1-2 feet of dense snow formed the foundation of the snowpack on slopes that did not previously hold snow. Cold temperatures quickly turned this snow into depth hoar on all aspects, creating a perfect recipe for avalanches.

Heavy snow and wind in early December created very unstable conditions. A foot of snow totaling 1" of snow water equivalent (SWE) put the first significant load on the early season weak layer. We issued the first avalanche warning for the mountains near Bozeman on December 2nd and the southern mountains on December 5th. Ski patrols at Bridger Bowl, Big Sky, and the Yellowstone Club triggered large avalanches that broke 3-4' deep and were more widespread on slopes with the basal October ice crust.

Between storms in December, below zero temperatures formed another layer of weak facets. Snowfall resumed on December 10th, and a snowmobiler in the northern Madison Range near Big Sky was fully buried and recovered uninjured within 10 minutes. On December 11th a skier from Sun Valley, Idaho was tragically killed in



Gallatin: Consistent snow and wind produced large cornices across the GNFAC advisory area. Falling cornices became a significant hazard when conditions warmed up in March and April. Photo Eric Knoff

an avalanche near Cooke City. He was the seventh skier down a small slope. The avalanche broke 3' deep, 150' wide and failed on the facets above the October ice crust.

Three to 4.5" of SWE in the southern mountains produced dangerous avalanche conditions and warnings were issued on December 16th and 17th. During the warning, large natural avalanches broke on facets near the ground, and human triggered avalanches occurred days after the warning expired. Snowfall tapered off through the end of December, but intermittent accumulations kept things fresh.

2017 began with frigid temperatures and a dusting of snow. In Cooke City, a mid-January storm with 4" of SWE accompanied a three-day avalanche warning. Large natural avalanches ran full track and broke on facets that formed in mid-December. The end of January was marked by increased snowfall and a quick return to winter.

Between January 30th and February 11th, an historic storm dropped 10.9" of SWE in the mountains around Cooke City. This was the third highest 14-day storm total on record. On February 10th, the GNFAC issued its first ever EXTREME avalanche danger, a rating validated by historic avalanches on February 11th.

1st ever  **EXTREME**

Avalanche activity tapered off quickly after this historic storm and persistent instabilities were not widespread in the mountains around Cooke City. In the southern Madison Range and mountains near West Yellowstone a couple of different weak layers formed between storms in mid-January and early February. In mid-February a snowmobiler triggered a slide that partially buried another rider. Snow tapered off and stability improved in the southern ranges towards the end of February.

The Bridger Range received a February farewell of cold smoke powder reported by the majority of skiers as the deepest snow they've ever skied.

Six feet of snow over two days averaged 3% density and fully engulfed skiers all weekend. We issued an avalanche warning the second day of the storm due to deep snow. Avalanche activity was confined to the new snow and instabilities diminished quickly with the lack of widespread persistent weak layers.

March started quietly with only a few inches falling in the first five days. Winter returned on the 5th with measurable snowfall being recorded for six straight days. Snow totals were heaviest in the southern mountains, which prompted an avalanche warning for the mountains around Cooke City on March 9th. Large natural avalanches were observed during this time and two separate close calls were reported by riders triggering large cornices. In both events, the riders were able to stay on the ridge while their machines took the ride over the edge. In one incident, a rider's snowmobile tumbled over a 150' cliff with large chunks of cornice, a close call indeed. Fortunately, nobody was injured in either incident.

By the middle of the month, winter loosened its grip and temperatures rose well above average. Wet snow instabilities became the primary avalanche concern as the snowpack began to transition. By the third week in March, the snowpack had turned isothermal in lower elevation terrain and access became limited. While everyone prayed for snow, the big question became – Will it freeze again? Thankfully, temps cooled off by the end of the month and normal spring weather ensued.

With a standard freeze-thaw cycle in place, stability remained good through the early part of April. Bridger Bowl closed on April 3rd and Big Sky closed on April 15th. With one ski area out of operation and limited access in the backcountry, the GNFAC issued its last advisory on April 9th. Despite an active start to the season, the GNFAC recorded the fewest number of avalanche incidents in five years, 31 total.

—Alex Marienthal & Eric Knoff

230,000
website visits

It was an epic winter in western Wyoming. Copious amounts of moisture moved into the region beginning in early October and continuing into early March. Drier conditions ensued in April, May and June. Terms like “atmospheric rivers” and “the pineapple express” were used frequently by the mainstream media. This was not fake news for backcountry users in our forecast region.

Although mean average daily temperatures were below normal in December and January, warm air intrusions caused the freezing level to rise into the upper elevations during storm cycles that occurred in October, February, and April. Season snowfall totals in the mountains ranged from 443 to 676 inches. Many records were broken and some were shattered. Moisture records occurred at all elevations. Due to multiple rain events at the lower elevations most of the snowfall records occurred at the upper elevations.

October was one of the wetter months ever and smashed all of the old records in the region for the month of October. At Yellowstone Lake the moisture in October 2016 was two times greater than the previous record during the past 108 years. There were four storm cycles during the month. Each was warmer than the previous cycle. During the last cycle it rained to an elevation of 11,000 feet. Record snowfall for the month occurred at the upper elevations.

Bridger-Teton: The Rendezvous Bowl weather station received 676 inches of snow and over 75 inches of SWE during the 2016/2017 season. This site had record snow depths in October, December, February, March, April and May. In this image, taken on February 28, Patrick Wright is working in a deep excavation in an effort to extend the height of the station and keep the instruments above the snow surface. *Photo Bob Comey*

Record moisture totals from the three-month period of December, January, and February occurred in western Wyoming. February snowfall at the Jackson Hole Mountain Resort and the water content of that snow were the greatest in 51 seasons. At the Rendezvous Bowl snow study plot, at an elevation of 9,360 feet, record snow depths for the date were set on multiple days in October, December, February, March, April and May. On April 28 this site experienced its deepest snow depth ever recorded. Record winds were recorded during a powerful storm on February 7. During this event wind gusts to 183 miles per hour were recorded at our Mt. Coffin weather station. These winds caused 17 steel power poles to collapse near Teton Village. It took five days to restore power to portions of Jackson Hole including the Jackson Hole Mountain Resort.

At the upper elevations a late October rain crust became the bed surface for a deep slab avalanche cycle that began in December and ended in January. Extreme avalanche conditions occurred at the lower and mid elevations in February when a surge of subtropical moisture created a wet snow avalanche cycle that caused havoc on the roadways in the Snake and Hoback River Canyons. During this storm cycle large wet slides occurred on steep slopes that have historically not seen avalanche activity.

There were two avalanche fatalities. One involved a resort employee who left the Grand Targhee Ski Resort boundary and went missing on the day before Christmas. His body was found a week later under avalanche debris. Searchers be-

lieve he triggered a cornice release and was carried over a 500-foot cliff before being buried. The second fatality involved an experienced local snowmobiler who went out during extreme hazard on February 9 and was caught and buried by a wet slide. During this season there were 25 instances reported to the avalanche center that involved people being caught by avalanches. In those instances, eight people were partially buried, three were fully buried, and three were injured.

Funding obtained from a Recreational Trails Program grant enabled the center to increase our staff presence in the backcountry and maintain our avalanche education presence in central Wyoming. These efforts were conducted by Jim Springer, Chris McCollister, Margo Krisjansons, Mike Nelson and Matt Workman. Patrick Wright was employed by our Friend's organization to create data analysis tools that have helped improve the accuracy of our advisories. Patrick has worked on multiple glaciology projects on the Greenland Ice Sheet and has master's degrees in atmospheric physics and glaciology.

In other news, the number of contacts to the center for avalanche hazard information increased from 1.5 million during the 2015/16 season to 2 million during the 2016/17 season and the avalanche center obtained office space in a brand new Forest Service building.

—Bob Comey

Zero Avalanche Fatalities in Utah for the first time in 26 winters

Despite heavy snowfall and periods of Extreme Avalanche Danger during the 16/17 winter, no one in Utah was killed in an avalanche. The last time this happened was the 1990/1991 winter. The majority of avalanche activity was storm related. The Alta Guard station broke 500" of snowfall for the season on April 25th for the 18th time since 1944 and the first time since 2010/2011. Utah's avalanche fatality count is 116 deaths since 1939/1940 while our running average during the last 30 years has dropped to 3.0 avalanche deaths/year. This number is remarkable for a number of reasons, but most remarkable is that it sits in contrast to what we see as an exponential growth of backcountry user days over the past 30 years. One of the take-homes from this is that we feel that forecasting, outreach, and education make a difference. There's obviously a dose of good luck, but we're celebrating nonetheless.

One way to look at this increase in use with decreasing deaths is by plotting the running average for fatalities with the number of contacts at the Utah Avalanche Center. It shows a huge increase in views of our advisories and other products which is a decent proxy for backcountry usage. At the same time, it shows a slight downward trend in fatalities. We hope the combined efforts of all avalanche professionals can help maintain this trend.

Salt Lake, Ogden, and Provo Regions:

An “atmospheric river of moisture” were words that brought excitement and plentiful snow this winter. The mountains were mostly dry until consistent snow started falling in late November. Steady storms in December led to a crescendo in January and February, when some stations received snow 44 out of 59 days. Some faceted layers devel-





Utah: Mark Staples approaches a massive avalanche on Mittan Peak that destroyed mature timber with both wet and dry avalanche debris. This slide occurred during a historic avalanche cycle in the Wellsville Range in mid-January. Photo Toby Weed

oped between storms but were short-lived. The avalanche danger would yo-yo rapidly between peaks of instability followed by rapid stabilization. After a lull in March, a string of storms in April brought numerous powder days with avalanche problems ricocheting between storm snow, wind slab, and wet avalanches, often in the same day. The Wasatch developed an above average snowpack by the end of December, which held through the end of April.

The winter's forecasting mornings were shared by the forecasting team of Mark Staples, Evelyn Lees, Drew Hardesty, Greg Gagne and Trent Meisenheimer. For the Ogden area, Paige Pagnucco provided one field day and two forecasts per week.

Uinta Region: Craig Gordon forecasted for the western Uinta Mountains and spearheaded our snowmobile avalanche education. Like all regions across the state, the winter switch got flipped to the "on" position around Thanksgiving and the snowpack went from zero to hero in just a month. A consistent storm track ushered in strong, moisture-laden storms which blanketed the region with a deep, thick and mostly stable snowpack. It was unusually stable for this area which commonly has a weaker, more continental snowpack.

Logan Region: The Logan satellite office was staffed by forecasters Toby Weed and Paige Pagnucco who stayed busy with so much snow. Toby

focused on the Logan area while Paige split her time between Logan, Ogden and helping UDOT with forecasting in Logan Canyon. The first atmospheric river event in mid-January caused a historic hard slab avalanche cycle in the Wellsville Mt. Range with large avalanches in almost every drainage. Additionally Hwy. 89 in Logan Canyon closed due to an avalanche hitting the road. Of particular interest this season was the speed at which the snowpack stabilized after each storm, imitating more of a maritime pattern.

Manti-Skyline Region: Brett Kobernik moved south and worked full time for the first full season in the Manti-Skyline Region. He worked with Craig Gordon in this area in previous winters and split his time evenly between Salt Lake and the Skyline last winter. As with other regions, the Skyline received abundant snow and mostly stable avalanche conditions outside of the stormy periods with very few human triggered avalanches. In addition to public avalanche forecasting, Brett assisted UDOT in

forecasting for State Route 31 in Huntington Canyon which was closed during two significant avalanche cycles. The first started with a rain event which triggered numerous natural avalanches which trapped motorists in the canyon. Ultimately, Huntington Canyon was closed for a week before conditions were safe enough to clear the debris from the road. A second avalanche cycle occurred during a significant warming trend where numerous natural avalanches again put large piles of debris on the road. It has been many years since avalanches have closed the road in Huntington Canyon.

La Sal & Abajo Region: Eric Trenbeath continued forecasting for the mountains around Moab where the use of the

advisory is up by 75% from just two years ago. Heavy snowfall in mid-November created an instant base, lacking the usual early season facets with continued snowfall through January. Notable avalanche cycles occurred around December 16 and January 22. In February, the atmospheric river had largely dried up over the region, and as winter waned through the end of March, the once robust snowpack had shrunk to near 70%. Winter use in the La Sal Mountains continues to grow and receive attention in the media with articles in many popular magazines.

KBYG program: The 2015 KBYG film was selected as a finalist in the 2016 Banff Film and Book festival. The CAIC and UAC also prepared a new slide deck, distributed content to avalanche educators across North America. In Utah KBYG was presented 127 times to 7,700 people.

The Fourth Phase: We produced a five-minute video that was included with Red Bull's featured snowboard film The Fourth Phase. This video was viewed over a half million times. It discussed an avalanche that occurred in the film and promoted the KBYG program as a way to learn about avalanches.

New Executive Director: We are pleased to announce that Chad Bracklesberg has joined our team as the non-profit Executive Director. Chad will combine more than 20 years of corporate technology consulting and program and project management experience with a passion for backcountry skiing, Level 3 avalanche certification, years as a UAC observer, and non-profit experience to take over the non-profit UAC leadership role. Paul Diegel, Executive Director since 2007, will step into a special projects role focused on avalanche education and awareness.

—UAC Staff

KPAC

Kachina Peaks Avalanche Center

We had a great winter. From all perspectives 2017 was KPAC's best since our inception in 2005. We had snow, avalanches, record-breaking outreach, successful fundraising campaigns, enthusiastic community involvement, and best of all, no serious avalanche accidents.

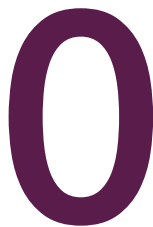
Fall-early winter: The season started out warm and dry until November when moderate snow accumulations resulted from storms passing to our north. On the day after our first snowpack summary was issued, the recorded settled snow depth at 10,800 feet on Arizona Snowbowl was 22 inches. Shallow snowpack and relatively cold tem-

Bridger-Teton Area: 676 inches of snow

Alta, Utah: 500 inches of snow

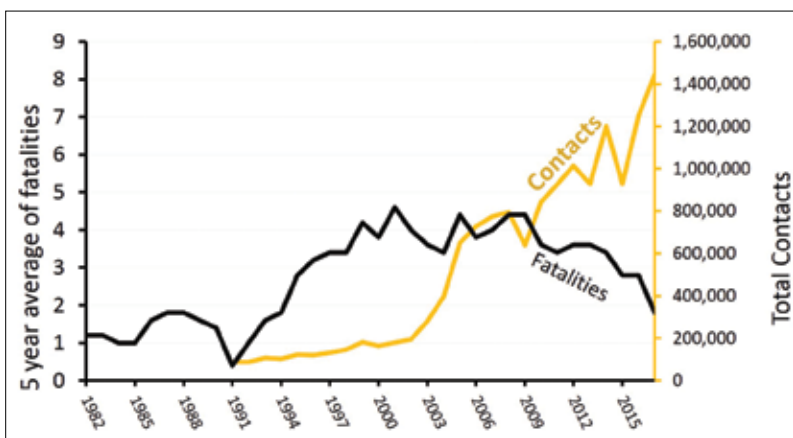
Kachina Peaks: 338 inches of snow

(0.25 mm = 1 in)



avalanche fatalities in Utah

Utah: This graph shows a jump in the number of times people are accessing UAC products (contacts) compared to the running 5 year average for avalanche fatalities.



peratures resulted in our usual early season basal faceting. Less common for us was higher than average humidity resulting in several observed surface hoar events. December 15th delivered a warm, wet episode with over 2 inches of snow water equivalent (SWE) and a snowline at 10,900 feet. A significant rain crust became a marker in the snowpack from then on, at all but the highest elevations. Then another sub-tropical influenced warm storm quickly followed, topped by a colder one on Christmas Eve dubbed the St. Nicholas Storm. Combined, these three events added a couple of feet of snow and up to 4 inches of SWE. Other than loose snow slides, no other avalanches were reported. By the New Year there were over 60 inches of settled snow on the marker stake at 10,800 feet. Periods between storms were gloomy and overcast from lingering localized cloud cover and icy fog, rather than our customary bluebird days.

Midwinter: The first half of January was characterized by weekly precipitation, and abundant high elevation rime ice resulting from strong southwestern winds. By January 13th snowfall totals had reached 115 inches. The season's first reported human triggered and natural avalanches occurred on January 14th when small/medium sized slabs released in Alison Clay (SS-AS-D2) and Telemark (SS-N-R2-D2) paths. These marked the beginning of our most active avalanche cycle. On January 16th, a second storm came in warm, creating a rain crust at most elevations. On January 18th evidence of avalanche activity was reported in Heck No Chute, but the time of occurrence was unknown. A third and most potent storm arrived on January 19th prompting the National Weather Service to issue a winter storm warning. These three storms became known as the "winter storm trifecta." On January 22nd Snowbowl recorded 53 inches of new snow in 48 hours. On the same day, explosive mitigation instigated by the ski patrol produced a large avalanche near the false summit of Agassiz Peak with a four-foot thick crown. Widespread natural avalanches were reported throughout the Inner Basin, particularly in Humphrey's Cirque and Snowslide Canyon where crown thicknesses of up to six feet were reported. Investigations indicated many slides ran on near-surface facets associated with the rain crust that had formed. Overall, the trifecta represented the 10th largest snowstorm series on record with over 93 inches of accumulation and seven to eight inches of SWE.

February started with unseasonably warm temperatures and increasing stability. However, this ended on February 11th and again on President's Day Weekend when two cold storms delivered eight and 14 inches of snow onto a near isothermal pack. Instability and natural avalanche activity resulted from storm slabs releasing on tiny near-surface facets at the base of



Kachina Peaks: Snowpack assessment on southerly slopes above Arizona Snowbowl, with Agassiz Peak in the background. Photo Alicia Vargo

the February 11th snow. Activity was observed on North Core Ridge, Humphrey's Cirque, and Temptation Slide Path. Weekly precipitation continued with another significant storm arriving on February 27th prompting another winter storm warning. This storm produced 24 inches of snow at 10,800 feet, three inches of SWE, and sustained south/southwest winds. This produced significant ridge top cornices. Not surprisingly, numerous natural avalanches were observed on NE, N, NW, and E aspects.

Spring: March was characterized by strong winds, diminishing storm productivity and periods of temperatures 10-15° F above average. On March 23rd and 24th we got our biggest spring storm amounting to 20 inches and two inches SWE. We also had several heat waves, multi-day periods with low temperatures above freezing at 11,500 feet (Agassiz station) and highs in the mid 50s. Wet slide activity was observed on warmer slopes even at elevations above 12,000 feet. April was a continuation of this theme. Conditions gradually stabilized as the isothermal snowpack matured. Wind sculpted sublimation patterns and sun cups developed as the season waned.

Statistics:

- Seasonal snowfall total was 338 inches, 130% of average.
- Published 22 weekly snowpack summaries and numerous short-format "storm updates" between November 27, 2016 and April 17, 2017.
- Conducted three free "Introduction to Avalanches" workshops for approximately 100 participants.
- The avalanche simulator was featured at Flagstaff's Festival for Science/Science in the Park event, and the STEM conference at Northern Arizona University.
- Served a record 78 students in Level 1 and Level 2

avalanche courses through our MOU with Prescott College.

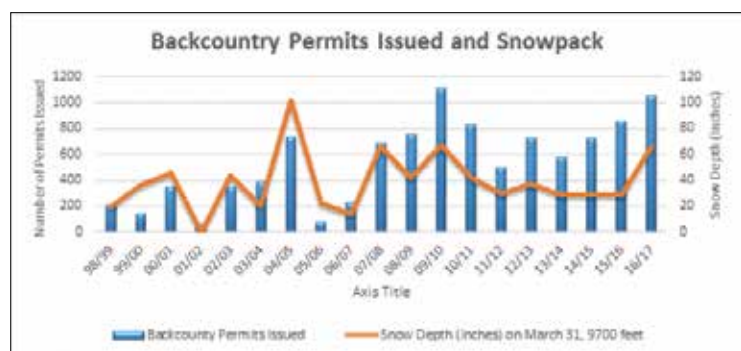
- Refined MOUs with Prescott College, Coconino National Forest, City of Flagstaff, and Northern Arizona University to provide services and expand collaborative funding opportunities.
- Coconino National Forest issued 1048 free winter backcountry permits, the highest number in the last six years, and second highest number since the program began almost two decades ago.
- Used a Microsoft grant to revamp the website for greater compatibility with mobile devices.
- Website use patterns broke all records with 54% increase in unique visitors, and over 100% increase in snowpack summary readership.

—David Lovejoy

CAIC Colorado Avalanche Information Center

The 2016-17 avalanche season in Colorado is well suited for this year's theme of extremes, outliers and fun facts. We had a late start which gave some relief to our hardworking ISSW 2016 crew, a historically snowy two weeks in January, several storm events measured in feet, a full burial on an open highway, a destroyed house, and a persistent and problematic surface hoar layer that doesn't commonly inhabit our snowpack stick around for long periods. The basal weak layer that usually plagues our snowpack didn't develop in most places, and other than the surface hoar, most of our avalanche activity was related to storm instabilities. The 2016-2017 total seasonal snowfall was near or above average for most of the state. An abundance of snowfall in December and January compensated for a very dry fall and spring.

There were approximately 3000 avalanches reported to the Colorado Avalanche Information Center (CAIC). We documented 66 incidents,





Colorado: Photo from a helicopter mission over Highway 550 on January 10th, 2017. Photo Ann Mellick

fortunate to all walk away without any injuries. The next day (December 11) two snowmobilers were fully buried and one partially buried near Rabbit Ears Pass. Again, they were lucky to walk away. Despite several more close calls, including three ski patrollers caught while on the job, we made it through December without serious consequences.

The first major storm occurred December 16 to 18, and dropped one to two feet of snow in the Central and Southern Mountains. A second storm system around Christmas dropped another two to three feet of snow and brought December snowfall to well above average across the state. Nearly all of Colorado's mountains had above average snow depths by the end of the month.

The New Year brought one of the snowiest months in the last 50 years to Colorado. The snowiest areas of the state picked up over 15 inches of snow water equivalent which was close to 13 feet of snow during the month. It was one of the most sustained and widespread avalanche months in memory. The first two weeks of January alone saw the snowpack nearly double across much of the state.

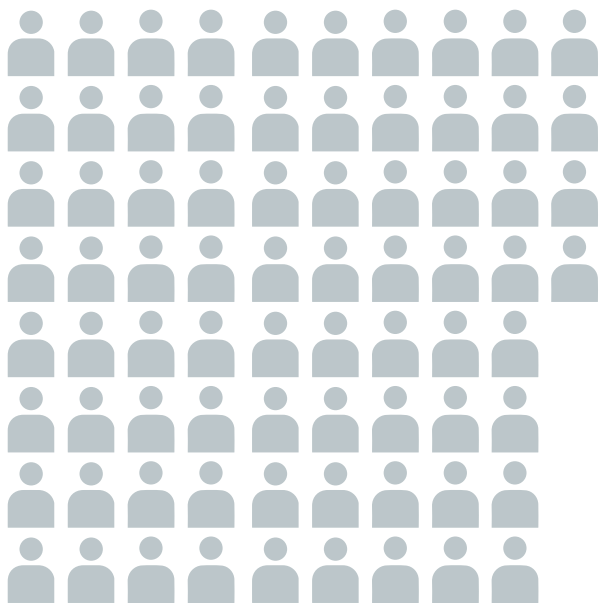
On January 9, a skier triggered an avalanche near Molas Pass on US 550. He was swept onto the open highway and fully buried for 15 to 20 minutes with an Avalung in his mouth. Fortunately, a local avalanche professional happened upon the scene while driving the highway, and along with the victim's partner, successfully extricated the buried skier alive. This incident served as the second stark reminder in as many years that backcountry recreation increasingly has the potential to impact assets outside the backcountry.

The intense storms caused a natural avalanche in the Vail Narrows that buried the entire westbound lane of Interstate 70 on the morning of January 10. A large natural avalanche released in the Bethel path mid day on January 10. The solid debris stopped 50 feet from Interstate 70, but the powder cloud ran over the open highway. The next day (January 11), a very large natural avalanche (estimated D3.5) destroyed a house near the small town of Montezuma. Fortunately, no one was home.

In the latter half of January, snowfall tapered off precipitously. It was enough, though, to bury an unusual surface hoar layer that had formed during a brief, mid-month dry spell. This layer was widespread across much of the state and remained active for almost a month after it was buried. It was the culprit weak layer in many incidents and close calls, including the one avalanche fatality in Colorado for the season when a snowbiker was buried and killed on Valentine's Day in the Flat Tops range. This is the second snowbike fatality in Colorado the last two seasons.

February produced less-than-average monthly snowfall across the state. The Northern Mountains reported about 60% of average monthly snowfall, with the Central and Southern Mountains coming in at around 80%. One significant storm at the end of February resulted in a short-lived avalanche cycle with several more close calls but no major injuries or worse.

If February was dry, March was even drier. The Northern and Central Mountains ended March with only one quarter to one half of average monthly snowfall. The Southern Mountains fared a bit better with the US550 and SH145 corridors reporting close to average monthly snowfall.



Colorado:



7,600
participants reached

with 83 people caught and one killed – notably less than the long-term average of around six per season. That's encouraging, but the numbers could easily have looked very different. We didn't see any significant change in the number of people caught. There were many close calls, including eight full burials and two critical partial burials where the victim survived. If even half of these close calls went the other way, Colorado would have near the average number of avalanche deaths for a season.

The small amounts of October snowfall melted away on all but the highest elevation shady slopes. The first half of November was warm and dry, and snowfall was well below average in the northern two-thirds of the state. A seasonal snowpack finally began to develop statewide during the third week of November, and though we received reports of our first human-triggered avalanches of the season, we made it through the month without any incidents or accidents.

Between one half to two thirds the season's total snow fell in December and January. The first of many close calls occurred December 10 near Jones Pass, when an avalanche caught a group of three backcountry skiers, fully burying one victim, and partially burying the other two. They were

Warm, dry conditions in the first two weeks of April allowed the snowpack to ease into spring conditions. The avalanche paths in the Southern Mountains were first to show signs of melting out completely. Small amounts of snow, mostly in the latter half of April, did little to increase the avalanche hazard. The snowpack across the state transitioned into summer conditions without a widespread wet avalanche cycle. Good corn conditions (with a few powder days mixed in) throughout May finally gave way to summer by the start of June.

On the education front, the CAIC and Friends of CAIC continued the Know Before You Go program statewide. Combined with our other educational programs, CAIC staff and trained instructors across the state conducted around 160 education events and reached approximately 7600 students. We look forward to improving and expanding these programs for next season.

—Brian Lazar

CBAC Crested Butte Avalanche Center

The winter of 2016-17 was indeed a memorable one! Last year's annual report concluded with "As always, the CBAC optimistically but unrealistically looks forward to a deep and stable snowpack next year." In many ways, we got our wish. As the season progressed, expressions such as "Pacific Southwest", "British Colorado", and even "rain on snow" and "glide avalanches" became more prevalent in our advisories than "depth hoar" or "monsters in the basement."

A prolonged drought through the fall stifled our typical basal weak layer development, and an active storm track through December and January put Crested Butte in the crosshairs for plenty of snow and avalanche activity (Figure 1). We dodged all fatal bullets this winter with several near misses on Red Lady, a full snowmobile burial, and a couple of traumatic avalanche rides resulting in unfortunate injuries. The winter was highlighted by our historic "Snowpocalypse" storm and avalanche cycle in January, which left our town and surrounding backcountry buried beneath one of the deepest mid-winter snowpacks on record and swaths of mature trees down across numerous valley floors. And yes! We got to paint it black. (See TAR 35.5 for "Going to Extreme") Going into February, an unusually widespread and reactive surface hoar layer was the spoiler to an otherwise stable snowpack, with tricky instabilities releasing into low angle terrain and in dense aspen groves (Figure 2). After our surface hoar layer was buried about 18-24" deep,

we were consistently getting no results from ECTs, but just about every single slope we touched that was steeper than about 31-33 degrees would slide. An exciting and unusual layer for us!

How's this for an outlier?

A warm spell in February spurred nearly 10 glide avalanches and we got to mention them in our daily advisories. By early March, we were able to wave farewell to our all-too-familiar persistent slab concerns and enjoy an amazing spring with plentiful and dust-free snow coverage in the mountains (Figure 3). Just in time for Zach to pack his bags for the rainiest April on record in the Flathead. "Wait...it rains here?"



Crested Butte: Figure 1—Another desperate attempt by CBAC to overcome persistent slab message fatigue. Photo Lydia Stern



Crested Butte: Figure 2—A series of inversions followed by a windless storm left us with an unusually widespread layer of surface hoar that plagued the mid and low elevations of Crested Butte for nearly a month. Photo Zach Guy



Crested Butte: Figure 3—A rare treat to see our mountains plastered with snow like Alaska. Here the east face of Gothic Peak shows fresh slab and loose snow activity following a late February storm. Photo Arden Feldman

Our CBAC team rose to meet an exceptionally challenging and exciting season. During "Snowpocalypse," the Crested Butte school system closed for the first time in decades, the town's public works was crippled, and even the ski resort shut down for a day. The CBAC forecasters didn't miss a beat; we were racing 100 mph all season to keep up with conditions, and we easily surpassed the number of field days, observations, and media content of any previous season. The public was thirsty for more information: our Awareness Night and Beacon Brushup events were overflowing capacity, and our usage statistics show a 20% increase on our website and twice the audience on our social media outreach since last year's benchmark season. Our goal is to meet the growing needs for accurate and tangible avalanche

information, and we couldn't do it without the overwhelming support from our community. So now for the fun fact. CBAC got its first powder sled thanks to a community grant. On its field debut, forecasters Evan Ross and Zach Guy decided it would be more efficient to try and break trail off-road to the top of Mt. Emmons to do a crown investigation rather than take the standard two-hour skin track. They spent eight hours getting stuck and never made it more than a few hundred feet above the road. You're in for a real treat, FAC.

Thanks for another great season!

—Zach Guy

MWAC Mount Washington Avalanche Center

Copious snowfall and a number of changes at MWAC defined the past winter on Mount Washington. From October through May, the Summit received 396 inches of snow. A number of significant temperature fluctuations provided a mixed bag of conditions throughout the season. A number of days brought enough low-density powder to suggest that our forecast areas had teleported a few thousand miles west, and spring skiers took advantage of skiable snow which held through Memorial Weekend in Tuckerman Ravine. We issued 136 Advisories from December 9 to April 23, with a number of General Bulletins preceding and following our 5-scale forecasts. We also began providing Avalanche Watches and Warnings through the National Weather Service, with four Avalanche Warnings over the season.

December started with a bang, with 28 inches of snow falling in the first week and 90 inches in the first half of the month. Snowfall plus wind-transport quickly filled our rocky avalanche paths. The first natural slide was reported on December 10, with the 12th seeing some danger ratings reach High. A rain/refreeze event which created a robust crust, the first of several over the season, brought firm conditions before a Nor'easter deposited several feet and our first NWS Avalanche Warning just before the New Year.

A snowy pattern briefly held in early January, but another rain crust and solid refreeze soon made crampons a more appropriate tool than skis for the remainder of the month. Perhaps the ice climbers deserve some love as well. Overall, the month of January saw only half of December's snow totals along with minimal avalanche activity.

Skiers were rewarded in February with the legendary Mount Washington wind relaxing for a few storms early in the month with unusually blower conditions above treeline. A significant wind and snow event built large slabs for February 12th, which led to a rare Extreme danger rating, an NWS Avalanche Warning, and a majority of paths sliding naturally, some repeatedly. More precipitation and wind pulling snow from our prime fetch areas into our upper start zones ramped hazard back up to High by the 16th, with another Avalanche Watch provided and a widespread, nighttime natural avalanche cycle ensuing.

Late February and early March felt very much like spring, with melt water and rainfall percolation wetting our upper snowpack. A solid refreeze ensued, followed by a return of snowy winter conditions. Wind scouring kept new snow from sticking to this crust in many locations for weeks. Heavy snow returned late in the month, ultimate-



Mount Washington: Duchess slide path, skier triggered avalanche, 12" new snow on light winds, April 1, 2017. Photo Helon Hoffer

ly culminating in the building of a barely cohesive storm slab which was the culprit of a rash of human triggered avalanches on April Fool's weekend. That weekend, a combination of luck and safe travel practices resulted in a number of dodged bullets. Nearly every avalanche path that was tested resulted in a human triggered avalanche, with no injuries resulting. Of note, a number of highly skilled users unintentionally triggered slabs with only one person in our forecast area caught and carried. This weekend served as excellent reminders of two key ideas: Don't ignore the most obvious red flags flown by weather data, and those who actively look for stability and a "go" decision will probably find clues to support their decision.

Wintry conditions persisted approaching the middle of the April, when a significant multi-day melt cycle was followed by a solid refreeze, setting up a relatively isothermal spring snowpack.

A number of natural cycles reached historic proportions during the season. The middle of February in particular saw a number of slides exceeding established avalanche paths. Additionally, a new avalanche path was established in dense mature forest below a relatively small start zone. Between these widespread natural cycles and the frequent, significant melt/freezing events, heightened instability did not tend to linger this season. Further, the wind on Mount Washington frequently reached speeds sufficient to scour deposition zones, effectively removing recently built dry slabs.

New this season to MWAC was a unique map of our forecast areas, shaded with danger rating colors and updated with each advisory issued. As we forecast on a micro-scale, essentially assigning a danger rating to individual ski runs and climbing routes, this new feature helps the public identify and more easily remember trends in ratings. We've

also continued messaging to the public via social media channels, in addition to the usual website, message boards at funnel points on trails, and direct public interaction.

MWAC staff collaborated with members of the public to form the White Mountain Avalanche Education Fund (WMAEF) as well this year. The WMAEF offered and funded several youth-focused avalanche education courses. Moving forward, the organization will continue to expand avalanche education efforts as well as to support the Eastern Snow and Avalanche Workshop, which we continue to offer each November.

The staff of the USFS Mount Washington Avalanche Center are also responsible for SAR in the general area which we forecast, the Cutler River Drainage on the east side of the mountain. This responsibility runs annually from December 1 through May 31, and includes training a number of SAR partner groups including the Mount Washington Volunteer Ski Patrol. While it makes us nervous to say so, it was a remarkably quiet year on the rescue front. No avalanche accidents required response, and other rescues were limited to patients without immediately life threatening injuries or just plain lost.

Amid these usual duties and the evolution of the avalanche center, two key staffing changes occurred, resulting in MWAC being short one forecaster for the duration of the season. After 15 years at the helm and 22 years as a forecaster, Chris Joosen moved West while six year MWAC forecaster, Frank Carus officially replaced him as Director in January. Another veteran forecaster, Jeff Lane, also moved on prior to the season, to be replaced by recent Northeast transplant Ryan Matz. Helon Hoffer remained in his role. Lily Carus, the avalanche rescue dog, remains in her role of garnering more public admiration than the rest of the staff combined. Hopefully, the remaining position will be filled prior to next season. Contact us at mwactucks@gmail.com, if interested.

—Frank Carus

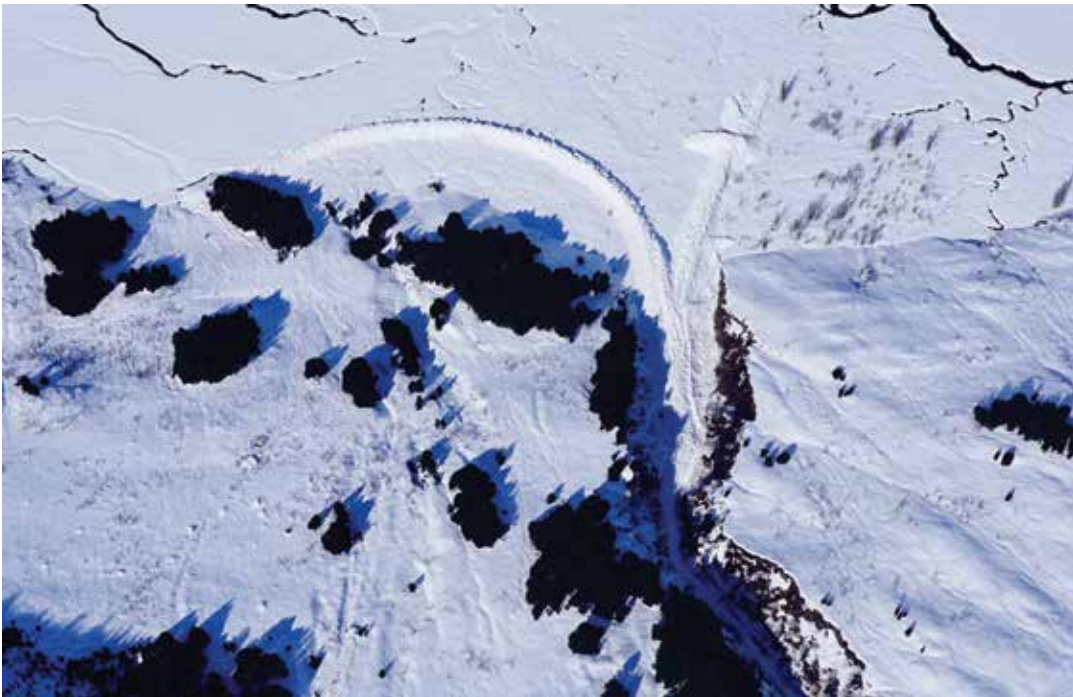
CNFAIC Chugach National Forest Avalanche Information Center

"WHUMPE.. There it is! Winter is here and so are the avalanches. Snow falling over the past two days has landed on a widespread layer of surface hoar."

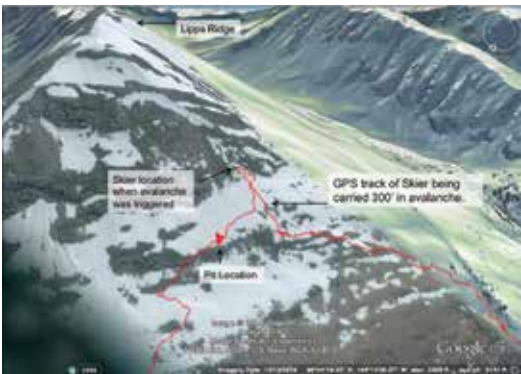
—Aleph Johnston Bloom, early season advisory

Tiptoeing. As the lower 48 saw record snowfall last season, Southcentral Alaska did not. In fact the Turnagain Pass region, the heart of the Chugach National Forest Avalanche Center forecast zone, saw 53% of its normal snowfall. Sandwiched within this meager 1-3 meter pack were 10 identifiable and reactive persistent weak layers throughout the year. Tiptoeing...

Despite the uncharacteristically tricky avalanche conditions, Alaska was fortunate to be below the yearly average of three fatalities/season. Yet we are sad to report, just barely. One snowmachiner lost his life in an avalanche near Cooper Landing and a 4-year old girl succumbed to injuries from a roof avalanche near Fairbanks. Many close calls were reported. One of these was a deep slab triggered on a slope I had ridden earlier in the day. I believe luck was on the side of many of us last winter.



Chugach: Impressive circular debris flow from a large wet avalanche running into the Placer Valley in early April. Photo Wendy Wagner



Chugach: GPS track of a skier's tour on Lipps Ridge (Google Earth Imagery). Party of 3 toured up lower Lipps Ridge, dug a pit, continued ascending and when deciding to turn around the party triggered an avalanche that propagated above them. The avalanche carried all three several hundred feet. Gear was lost but all skiers were ok and able to walk out.



Chugach: The first annual Observers Appreciation Night held at the Girdwood Brewery. Invited guests were recreational users and professionals who submitted five or more observations during the season. Photo Girdwood Brewery



Chugach: A full house turnout at Alaska Mining and Diving for a snowmachine specific gathering to discuss lessons learned. Photo Nick Olzenak

The internal workings at the CNFAIC are steadily growing and improving. With 3 ¼ employees, the center welcomed back all returning staff members: Heather Thamm, whom we stole from Alyeska Ski Patrol and Snow Safety several years ago. Aleph Johnston-Bloom, a 15-year veteran of professional avalanche education, forecast-

ing, and ski patrolling and is also the AAA Secretary. Graham Predeger, our ¼ employee that we wish was full-time, has been with the Center for 7 years and continues to assist with motorized outreach amongst other things. The CNFAIC Internship Program continues, and last season's recipient was Conrad Chapman from Fairbanks, Alaska. Conrad is a founding member of the recently formed grassroots Eastern Alaska Range Avalanche Center (EARAC) based in Fairbanks. He took a semester off from his Earth Science Studies at the University of Alaska Fairbanks to participate in the internship. This program is quite valuable to the Center and we plan to keep it in place in the future.

The CNFAIC had another successful season of avalanche outreach to the motorized and non-motorized communities. We continued with our "Fireside Chat" format, which offers free topic-based avalanche presentations to the public. CNFAIC staff also continued to offer free hands-on Rescue Workshops, including one in collaboration with Hatcher Pass Avalanche Center for the 3rd annual Hatcher Pass Rescue Workshop. One highlight in particular was a snowmachine-specific evening talk in late November. Only 20-30 riders were expected to attend, yet 120 showed up! Our strategy for successful snowmachine outreach is evolving and this night's focus was on three recent snowmachine avalanche fatalities. These events were still fresh in riders' minds and many attendees were intimately involved. The crowd took the reins with some direction, told their stories, discussed what they wished they had done differently, what they did right, and what they wanted every rider to know. A big emphasis of the talk was how to recognize avalanche terrain and how to "Get Out of Harm's Way." It was a powerful evening that got significant attention on social media afterward.

As is the case with other Avalanche Centers, we rely heavily on a vast array of partners, both within the professional avalanche community and outside. To list a couple: Alaska Mining and Diving Supply, a longstanding supporter, helped facilitate a "loaner sled" (a 2017 SkiDoo 850 SP) for the 5th year in a row; then, support from Beaded-Stream and KCI has allowed us to install a Tincan Snow Study plot that houses a snow temperature

array –viewed real-time by anyone interested. This summary would not be complete without recognizing our non-profit arm, the Friends of the CNFAIC. This group has continued tirelessly to push forward. They support the Center with roughly ½ of the overall CNFAIC operating budget. New for the group was the hiring of an Executive Director March of 2016, Emily Kurn. We are excited to have Emily back for this year and look forward to growth in the future!



Numbers and highlights:

- 163:** Turnagain Pass daily advisories
- 128:** Days with Persistent Slab or Deep Persistent Slab problems
- 7:** Layers of reactive buried surface hoar
- 238:** Seasonal Snowfall (inches), roughly 50% of normal
- 1-3:** Feet of snow at sea level lasting most the winter (#snowtosealevel)
- 20:** Saturday morning Summit Lake area summaries
- 1:** Times the keys were locked in the G-Rig at the trailhead
- 4:** Avalanche Warnings
- 1:** Special Avalanche Bulletin
- 342:** Alarms set for 4am or earlier
- 138%:** Increase in public observations (292 this year!)
- 179%:** Increase in website unique visitors
- 822:** Powder miles ridden on work snowmachines
- 1,433:** Total people reached in outreach events
- 575:** Total snowmachiners reached
- Countless:** Whumpfs

—Wendy Wagner

AAIC Alaska Avalanche Information Center

Alaska returned to a more typical weather pattern which many long-time Alaskans are used to; cooler temperatures with snow down to sea level, interspersed with dry, windy periods. Interior regions and the Kenai Peninsula were blanketed with more snow than average, while some coastal areas went dry. Despite the variance, Alaskans enjoyed an overall more snowy season riding, skiing, and recreating in avalanche terrain. Several storm cycles created multiple days of high avalanche danger. The AAIC team worked hard to keep the public informed of these conditions.

The five community avalanche centers that make up the AAIC provided 517 avalanche forecasts, received numerous observations, taught education outreach, and contracted avalanche safety services for companies and organizations that reached from Haines to Fairbanks to Valdez.

Partnerships with cities, boroughs and municipalities have continued to grow and strengthen along with support from local newspapers, radio, snowmachine clubs, universities and the Alaska Department of Public Safety.

Our education team taught a total of 46 community awareness classes as well as seven AIARE Level 1 & 2 courses. In December, we hosted an AIARE Instructor Training Course in Valdez with participants

from Alaska and outside including New Hampshire, Colorado, California, and Kashmir.

The AAIC also hosted the annual Snow Safety Summit, held November 3, 2016, in Anchorage just prior to the Southcentral Alaska Avalanche Workshop, hosted by CNFAIC November 4. The objective of the annual Summit is to bring together individuals, companies, organizations, and state agencies who utilize and benefit from the snow safety services provided by avalanche practitioners in order to meet, network, and brainstorm better

ways to serve Alaskans. The 2017 Summit, sponsored by Conoco Phillips, is set for Thursday, November 2, 2017 at Alaska Pacific University. More details coming soon at www.AlaskaSnow.org.

Alaska reported two avalanche fatalities during the 2016-17 season. A snowmobile rider was caught and killed while riding near Cooper Landing on the Kenai Peninsula, and a four-year old girl in North Pole was buried and killed in a roof avalanche.

The AAIC team continues to work hard to raise awareness and share information about avalanches in Alaska.

Numbers, total for all centers:

Published forecasts: 517 (33 Cordova, 6 EARAC, 144 Haines, 29 HPAC, 306 Valdez)

Website Hits: 49,885

Education programs taught: 53

Served more than 2,000 individuals with training

Following is detailed information from the five current AAIC community avalanche centers.

Cordova Avalanche Center:

Cordova temperatures were colder than the previous two winters, allowing our local ski lift to operate for the first time in as many years. The snowpack slowly increased into February. However, mid-month a warm storm brought five inches of water in two days; the freezing line climbed above our local peaks, causing large avalanche activity. Strong northerly outflow winds then scoured the upper peaks, followed by a month-long drought. Snow returned by April along with more avalanche activity. High daytime temperatures towards the end of April began our spring shed. All in all, the average winter temperature sat slightly above normal; below normal winter precipitation combined to bring a slightly below normal maximum height of snow. No avalanche activity reached the highway.

—Hoots Witsoe

Eastern Alaska Range Avalanche Center:

The Eastern Alaska Range once again saw long periods of drought this winter with below average total snowfall depths. Regular high winds and periods of above freezing temperatures (which seem to be the new norm) kept snowpack depths variable, with some areas remaining scoured all season long.

Our second year as an organization saw continued success in collecting and sharing user observations on social media and our website. We were also able to maintain and expand our education and outreach opportunities in Interior Alaska with 17 classes that reached over 400 students.



Alaska: Mt. Heney Peak in Cordova, snow covered for the first time in several years. Photo Hoots Witsoe



Alaska: Sarah Carter provides a visual avalanche lesson for students during a public outreach program. Photo Kyle Sobek



Alaska: This avalanche was observed in a remote area after it occurred, by means of the loaner snowmobile. A significant persistent slab avalanche on a small slope, was triggered by a solo snowboarder who also accessed the area by snowmobile. This avalanche demonstrates the persistence of the avalanche problem, occurring two weeks after the peak of the cycle. He escaped uninjured. Tracks show the entrance point at the apex of the crown and the escape route, viewers bottom left at the base of the debris. Photo Jed Workman

During the Arctic Man Ski and Sno-Go Classic in April, EARAC worked with other AAIC centers to provide an avalanche forecast for five days during the event and was widely regarded as a success and valuable asset to the event. Additionally, EARAC also joined forces with the Valdez Avalanche Center to issue Advisories during periods of heightened avalanche danger.

—James Smith

Haines Avalanche Information Center:

This was a big year for the Haines Avalanche Information Center, with an increase in funding from government and private sources, a busy event schedule, and ever increasing backcountry use.

In terms of snowpack, it seems to have been a somewhat “average” year, with ~59” of accumulated SWE in maritime zones and ~29” in interior areas. Increasing backcountry use at Chilkat Pass is making our forecast there ever more important. We also provided an event forecast for the 1st annual Haines Alpine Adventure Race, which was a big success.

This season brought a major increase in data availability, as we now have four new mountain weather stations online in our area. One of these stations was installed and managed by HAIC/AAIC, and has illuminated how our local mountain micro climates affect conditions.

Our community has managed another season without an avalanche fatality, though there were

several close calls reported, and two full burials reported second-hand but not confirmed. No doubt the pressures to not report accidents are huge. Our community is in need of more avalanche education, and a culture shift to encourage risk reduction, information sharing, and learning from our mistakes. These are ongoing goals for the future, and while progress is being made, it is a slow process.

Overall, stability was good for much of the season, but this year’s outlier came in the form of a nasty rain crust-facet-NSF sandwich that formed late February and was buried by a meter of moderately hard slab. It wreaked havoc through spring,

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Alaska: Wind scoured the Thompson Pass region near Valdez through the winter. Photo Kevin Salys

scaring the heck out of people with shotgun-blast whumpfung, basin-wide propagation, and remote triggering. In mid-March, most users were well aware of the danger and taking it easy. By the end of March however, a moderate increase in stability led to a large increase in risk taking, despite our warnings about deep persistent slab danger. This was the period in which burials were reported to us second-hand.

—Erik Stevens

Hatcher Pass Avalanche Center:

The Hatcher Pass Avalanche Center had a successful 2016-17 season despite a late snow start. Even though precipitation was low, we welcomed the colder version over last year's abnormally warm winter. This winter resembled what Alaska used to be like when the old-timers said..."It ain't Alaska unless winter is as cold as 'bleep' and the mosquitoes are as thick as 'bleep' in the summer."

Despite a colder winter, we never received the snow dreamed about during the daily 18+ hours of December darkness. November through March ranged from about +10° F down to about -33° F, although mostly below zero. The Fishhook Basin reported 57% SWE of the official median since 1964.

Low snow, cold temps, and clear skies early in the season set up an abnormally weak base. By December, we received enough snow to build a persistent slab issue that lasted throughout the season. This problem started with many remote-

ly triggered avalanches up to D2.5 which slowly tapered off with only minor blips of reactivation.

Considering the sensitivity and size of this significant avalanche cycle, and the normal heavy backcountry usage in the area, it was impressive that no injuries or fatalities occurred. It appeared that after a tumultuous 2015-16 season, avalanche awareness reached an overall higher level.

HPAC provided avalanche advisories every Saturday, November through April, and additionally as warranted by weather.

Highlights of the season included teaching our annual free rescue workshop in conjunction with the CNFAIC, the Alaska Avalanche School (AAS), and AAIC, with over 50 attendees. We also co-hosted a "Know Before You Go" class with the AAS in Palmer.

This was our second season using the joint CNFAIC/HPAC observation platform. User participation is high and the clear, structured format has been very helpful.

HPAC was accepted for a snowmachine loaner program from Alaska Mining and Diving in Anchorage. This machine was stored in the rescue cash at Hatcher Pass, enabling forecasters quick access, widening our core observation area, and was available for search and rescue.

Local support increased this season with two different community grants equaling \$7000 from the City of Palmer and the Fishhook Community Council. HPAC held our Annual Fundraiser and Cabin Fever Reliever, including silent auction, bluegrass, and local beverages. This event brought in \$5000.

For the first season ever, HPAC's budget supported a small salary of \$5000 for a single forecaster this season.

The "Are You Beeping" sign project is on track for installation beginning this summer and autumn. Three signs with beacon checkers and solar panels, one temperature/humidity sensor, and one trail counter have been acquired. Local companies have generously donated batteries and supplies to limit costs to the center.

HPAC started an Advisory Board with seven Mat-Su valley locals, and held regular monthly meetings all season. This group has been a wonderful, new area of growth for the seven-year old

"Jed and Allie Show". We are looking forward to having the strength of this group propel HPAC towards a more permanent and sustainable avalanche center.

—Allie Barker & Jed Workman

Valdez Avalanche Center:

It was a challenging winter on the east side of the Chugach this year, where high pressures had a dominating presence and overstayed their welcome. Long periods of cold, dry and windy weather resulted in only eight major storms. Several wind events stripped our high elevation, dry snowpack back to its base while filling in the low-lying terrain. Minimal precipitation and destructive outflow winds compounded into a very thin snowpack with persistent weaknesses you had to tiptoe around beyond mid-season. Our few large avalanche cycles were directly tied to two extreme wind events, a high reaching rain cycle and early season deep, persistent snow instabilities. In total, Thompson Pass accumulated 327" of snow (32" water equivalent), only reaching 65% (180" short of 507") of the historical average since 1951. The town of Valdez experienced a much cooler and snowier season: receiving 249" (25" water equivalent), 140% more than last season, yet still 62" short of a 311" average since 1971.

The shallow snowpack and lack of refreshes on Thompson Pass took its toll on recreationalists of all means, leading many to cancel or shuffle their spring skiing plans elsewhere. There were times where it seemed that everywhere but the Valdez area was receiving snow- quite the anomaly. But, as it always does, the Chugach magic quickly transitioned the snowpack and the great turns in paradise returned by the second week in April.

Overall it was a pretty safe season near Valdez, with minimal close calls and involvements reported.

As for outreach and forecasts, beginning in October, 145 daily forecasts were published this season, reaching over 9,000 unique users. An average of 150 people viewed the forecast each day with over 27,000 views for the entirety of this season. Peak timeframe was in mid-February near a large rain event and in late March/early April when snow returned after a long, high pressure period.

Beyond our daily public forecast, we established a remote and physical presence on Thompson Pass, offering field based education and outreach from a quonset in the heart of the camp and ski scene. VAC staff updated the forecast daily in addition to flying the avalanche hazard 'surf flag' colors high for all to see.

Educationally we offered many awareness programs packaged as mountain skills and riding safety combined with avalanche know-how. Student feedback to this more holistic 'mountain safety' was very positive. We taught several traditional AIARE 1 & 2 courses, including a motorized Level 1 taught by Mike Buck and Kyle Sobek. We hosted the first ever combined motor/human powered AIARE Instructor training, making stronger connections with our motorized community.

— Kevin Salys & Sarah Carter

The AAIC team will come together for our third annual retreat in July, 2017 to continue work on strategic planning, collaboration with other avalanche service providers, and building a sustainable, long-term future to serve Alaskans across the state with avalanche information, education and backcountry travel outreach. ▲





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