the avalanche journal


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Garibaldi North Glacier, Canada, BC
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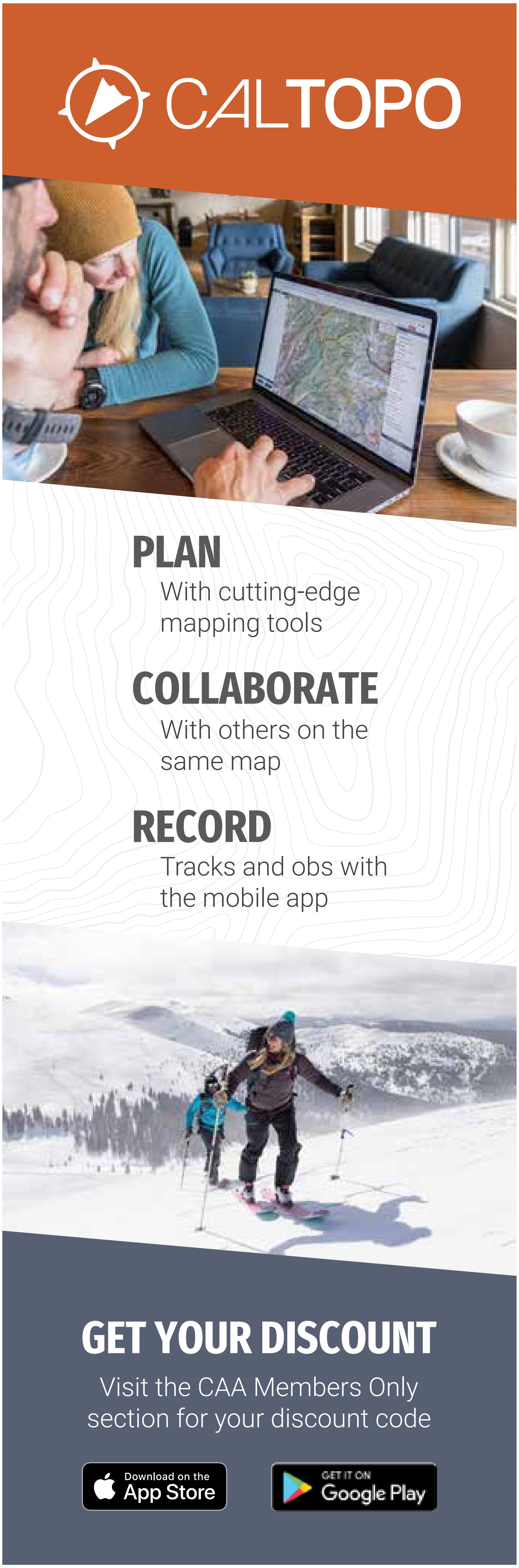
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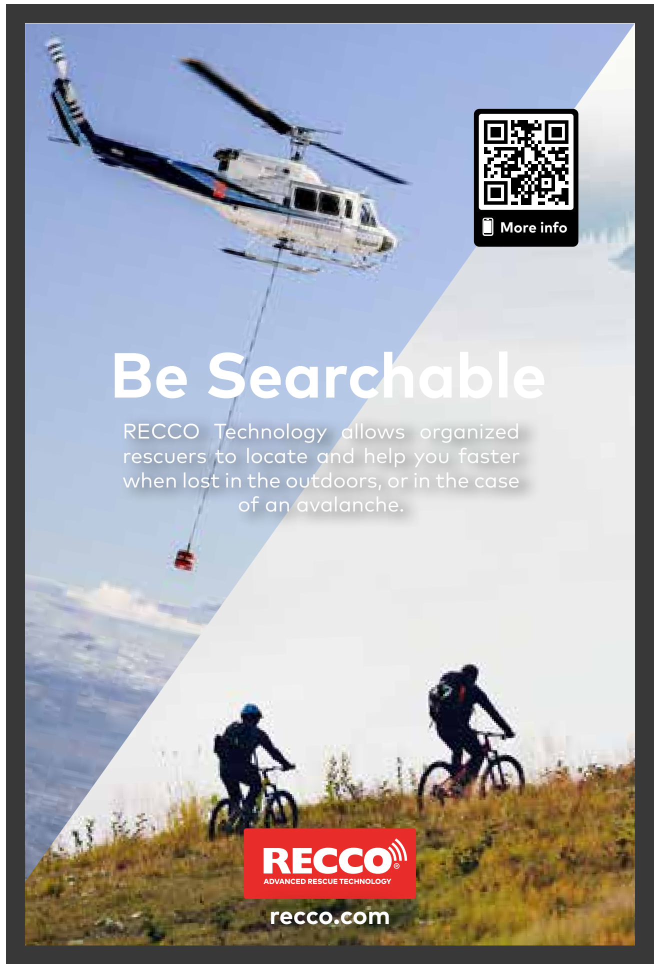
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CAA President

CAA President's Message

AS WE EASE INTO a new winter that is already shaping up to be an outlier due to the influence of El Niño, it's exciting to share some key updates and reflections from our community. This fall, after a five-year hiatus from in-person meetings (seven if we're only talking about North America), the International Snow Science Workshop in Bend, Oregon, was a particular highlight. Hot topics included advancements in modeling and simulation, applications of remote sensing and drones, and implications of climate change. CAA members continued to showcase their expertise and leadership, especially in the fields of avalanche forecasting and risk-based decision-making. I highly recommend checking out the conference proceedings at issw2023.com to find studies that are of special interest to you. At the risk of playing favourites, I recommend the excellent papers by Scott Thumlert, Jen Coulter, and Matt MacDonald as having broad appeal, amongst many others.

Looking forward, I'm excited to share that ISSW 2026 will be held in Whistler. The ISSW committee typically receives seed funding out of the revenues of the previous venue. However, after the unfortunate cancellation of ISSW 2020 in Fernie, the Whistler committee faced some financial hurdles. To bridge this funding gap, the CAA and the Avalanche Canada Foundation are pleased to support the ISSW Whistler Foundation in the form of a loan, ensuring this valuable event goes ahead and is accessible to CAA members.

On the topic of continuing professional development, our joint CPD series with the ACMG and CSGA continues to be a great success, attracting nearly 300 members to this fall's sessions, with almost 1,000 individual registrations.

This is an apt opportunity to remind you of the need to not only meet CPD requirements of membership, but also to document your activities. Maintaining supporting evidence is essential to demonstrate the evolution of your professional competencies through your career. We're working on making the CPD tracking and membership audit processes more efficient.

MAKING PROGRESS

The staff and membership committee are working on streamlining general membership procedures. Over the summer, we moved the bulk of the new membership application review process from volunteers to paid reviewers, with a service goal of processing applications within four weeks. This will lessen the burden on volunteer committee members and provide a speedier process for applicants.

There has also been significant progress in the rollout of the new Avalanche Educator membership categories and their supporting courses. The new Instructing in Avalanche Terrain—Foundations course is available online, and a beta version of Instructing in Avalanche Terrain—Basic was set to launch in January. The recognized certification profile for the Basic Avalanche Educator membership has been established and can be found on the membership section of website, and the competency portfolio application process is open for applications.

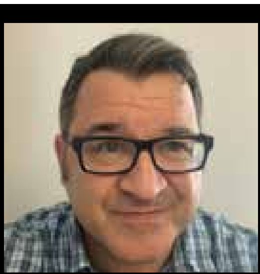
Focus has now shifted to the development of field courses in support of Advanced Avalanche Educator membership. The recognized certification and competency portfolio processes are open to those with advanced training, such as guides. To learn more, contact Operations Manager Rosie Denton.

On the financial front, I'm pleased to report the CAA closed out 2023 on solid ground. Despite the challenging inflationary climate, the staff's conservative budgeting has paid off. We've managed to achieve positive cash flow across all our main areas: membership, Industry Training Program, and InfoEx, which allows us to continue investing in special projects and new initiatives such as an update to OGRS in the coming year.

I'd like to close with a call to action. The board continues to actively recruit members interested in joining the Education Committee. This committee plays a key role in keeping our ITP curriculum relevant and comprehensive, ensuring it meets the needs of the avalanche industry from the perspectives of both workers and employers. While involvement with ITP is an asset, it is not a requirement. We're on the lookout for individuals with a background in education and those working at higher levels of practice across different industry sectors. If you are interested in participating or would like to learn more, please email president@avalancheassociation.ca.

Thank you all for your continued support and involvement with the CAA. I wish you a safe winter.

Eirik Sharp, President



Joe Obad
CAA Executive Director

Executive Director's Report

DEVELOPING RESOURCES

LIKE EIRIK, I HOPE the winter season is off to a strong start for everyone. By the time you read this, most of you have completed staff training and are in the full depths of operations.

Whether you've called already or have lingering questions, we encourage all operations and members to look to the CAA as a resource.

Eirik rightly celebrates the success of the joint CPD sessions this fall. As a resource, the CAA can offer these sessions with our partners, but we can do more with your help. If there are areas you feel you need to shore up your practice or the members of your operation, let us know. We can shape those ideas into future CPD offerings.

Likewise, if you have expertise you would like to share, the CAA can get the word out about events, whether they are in-person or online. Professional development is a dynamic between all members, where the CAA can play a role in bringing members together to advance avalanche practice. Get in touch if you have ideas—let's work together to bring value to the membership.

An area in which we are looking to do more for our members is mental health. Under the "Resources" tab of our website, you'll find our mental health resources, including our mental health vision. Its pillars offer support for prevention, critical incident support, post-incident support, and continued support.

Together with other mountain organizations, we are participants in the Canadian Mountain Community Critical Incident Stress Management (CISM) initiative. We look forward to complementing CISM with activity in the other three pillars of our vision to provide more comprehensive tools for your mental health.

The InfoEx platform, a cornerstone of the CAA's operational support, empowers industry stakeholders by fostering the sharing of observations and data within its subscriber community. Manager Stuart Smith and developers Martin Ho and Dru Petrosan work tirelessly to allow the platform to keep pace with the shifting demands of the web and the needs of subscribers. These demands sharpen our focus, given our responsibility to operate InfoEx as a high-reliance system. Given the dependence on the system by stakeholders further from the centre of the snow and avalanche world, InfoEx is increasingly functioning a lot more like a public utility—a system meant to supply goods or services that are considered essential.

With this in mind, we have looked to the government to complement subscriber fees for the development of InfoEx into the future. In the last four years, work has progressed under the MAInEx project funded by Public Safety Canada's Search and Rescue New Initiatives Fund. These funds have allowed us to contract external resources to work alongside our internal team. We are especially grateful to Public Safety Canada for an additional year of funding to allow us to continue working with external contractors.

Recently, we concluded work with our existing contractors and put out a request for proposals for new developers. By the time you read this column, we hope they are up and running.

We have also secured funding from Transport Canada. This required making the case InfoEx is integral to helping keep our national trade corridors open. We were pleased to learn this fall that Transport Canada agreed with our case and provided a new source of funding. We are now working with Transport Canada and Public Safety Canada to structure these funds to ensure our internal team can be complemented by the horsepower of external contractors through to the end of 2025.

To the average InfoEx user, this means advancing the platform to ensure efficient data sharing in the mobile environment with tools they've demanded to conduct operations around strong hazard and risk assessments. It means a reliable feed to Avalanche Canada for regional forecasts used by the public, members, and almost every employer with an avalanche safety plan in B.C.

Members and subscribers can look at the efforts on mental health, CPD, and InfoEx with pride. We hope you can see these efforts with some historical perspective. By the time you read this, our History Project site should be up at avalanchejournal.ca. Alex Cooper has done an amazing job picking up the strong foundation laid by John Woods, who conducted initial interviews. The indomitable Susan Hairsine helped us greatly with transcription. We hope you'll enjoy learning from the likes of Chris Stethem, Colani Bezzola, Phil Hein and others about the foundations of the CAA and its evolution. With their insights you might consider the marks you make on the history of the industry going forward.

Joe Obad, CAA Executive Director

Alex Cooper
Managing Editor

From the Editor

GOING DIGITAL

I'M VERY HAPPY to announce Avalanchejournal.ca, the home of *The Journal's* blog, digital archives, and the CAA History Project. I'm excited to bring forward this work that has been germinating for a number of years and merges several projects into one.

When I started at the CAA in 2019, I posted some old articles in a blog on the CAA website in an effort to give them more exposure and increase *The Journal*'s online presence. That never got much traction and the back-end was cumbersome, so I eventually gave it up.

Around that time, the Board of Directors allocated some funding to capture the CAA's history for its 40th anniversary. John Woods, a Revelstoke-based historian, was hired to interview Past-presidents, former Executive Directors, and other key figures from our industry. John completed a handful of interviews, but the project was sidelined by the pandemic.

Last summer, I was fortunate to be asked to pick up where John left off. I was handed a list of about 15 people to interview and set to work. I shook the cobwebs off my rusty interviewing skills and connected with industry legends I'd read about but never met. My first interview was with John Hetherington, who started as a Whistler ski patroller in the 60s, was a founding member of the CAA, and President in 2004-05, when Avalanche Canada was just starting. Since then, I've spoken to luminaries such as Jon 'Colani' Bezzola, Phil Hein, Chris Stethem, Bruce Jamieson, and Jack Bennetto. It's been a fascinating experience to learn so much about our industry, the history of the CAA, and the people who shaped the Association.

As the interviews started to come together, we discussed what we would do with them. We were also looking for a new place to host digital copies of *The Journal* as we exceeded the limits of our Issuu account. I proposed a website that would not only host the audio recordings and transcripts, but also include the complete archives of *The Avalanche Journal*, digital copies of important CAA documents, and a blog featuring *Journal* articles and other industry news. Instead of incorporating this into the existing CAA website, we hired a contractor to build us a brand new one. The result is Avalanchejournal.ca.

The website isn't in its final form. There's still a way to go until all 134 issues of *The Journal* are online; we have PDFs going back to Volume 60 and need to scan the rest. There's a few more interviews to conduct and transcribe. I also need to spend some time in the basement of CAA HQ and start scanning important documents from our history to make those available. Still, even now, there's plenty of material for you to enjoy, and more will come online over time. We hope Avalanchejournal.ca will become a valuable resource for members and even the public as it grows.

***

I feel I need a whole other column to write about ISSW 2023 in Bend, Oregon. Needless to say, I am extremely grateful I was able to attend, and it was an absolutely invaluable experience. I'd like to thank Joe and Rosie for including me in the CAA contingent. Like many, I found the daily afternoon social and poster presentations the most valuable part of ISSW, as they provided the opportunity to engage directly with professionals from around the world. I was able to connect with many European and American researchers and practitioners and have come away with a long list of potential articles.

It's difficult to single out a single highlight, or even narrow it down to a short list (as I asked many Canadian attendees to do). One thing that struck me was how far along modeling has come. I remember when I first started to get interested in avalanches as a journalist some dozen years ago, hearing that individual avalanches were largely unpredictable. As I watched all the presentations on modeling, it made me think we might not be far from a time when forecasters have access to accurate snowpack models on their computers, and they will be able to run fairly accurate simulations of avalanche activity based on weather forecasts. People much smarter than me can probably chime in on how far we are from such a scenario.

This is the first of what I imagine will be several issues influenced by ISSW. I am grateful to the authors who were able to meet the tight timeline between ISSW and the mid-November deadline. Expect to read more articles from and inspired by the conference in future issues.

Alex Cooper, Editor

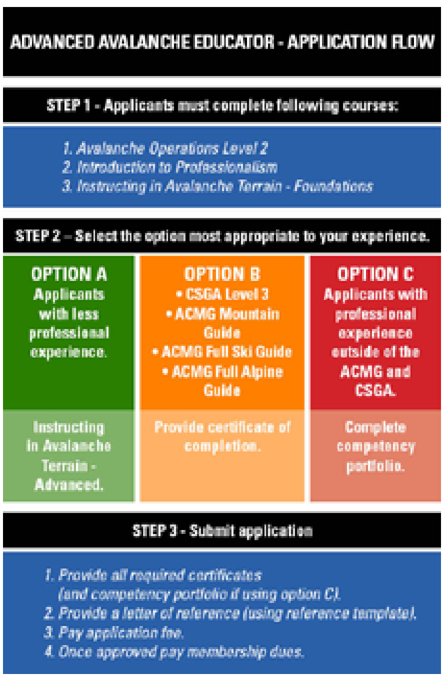
Basic and Advanced Educator Categories
New Options for CAA Membership

Joe Obad and Rosie Denton

ON DECEMBER 1, the CAA began accepting applications for its newest membership categories: Basic Avalanche Educator and Advanced Avalanche Educator.

These categories are for individuals who work within a CAA scope of practice limited to recreational avalanche education. They are not a requirement for Avalanche Professional or Avalanche Practitioner members who currently teach recreation avalanche courses. We have partnered with Avalanche Canada to develop these categories and ensure they meet CAA standards, while enabling successful applicants to teach Avalanche Canada's AST curriculum. The application paths for these categories are detailed below.

The online courses that support these categories are up and running. Instructing in Avalanche Terrain—Foundations was created this summer by our curriculum team working closely with Avalanche Canada. Introduction to Professionalism is also required of all new applicants, and has been available for several years.



OPTION A: COURSE-BASED APPLICATIONS

Course-based applications are intended to foster a path to membership for individuals who are challenged to acquire industry experience for reasons that may stem from geography or use of travel methods such as snowshoes or snowmobiles.

The field course *Instructing in Avalanche Terrain—Basic* is being offered in beta form in January 2024 to ski and sled participants. The ITP team will take instructor and student feedback to revise the course before it becomes a regular operational offering in the 2024-25 season.

We anticipate offering *Instructing in Avalanche Terrain—Advanced* in beta form in 2024-25 and fully operationalizing it in the 2025-26 season.

OPTION B: EFFICIENT PATHWAYS FOR EXPERIENCED APPLICANTS

Unlike the slower development for course-based applicants detailed above, ACMG, CSGA, and CMBGA members, or those that have completed CAA Operations Level 2, are able to access a quicker path to becoming educator members. Following the completion of the online courses (which should take less than 10 hours for most), applicants using Option B are likely to have their applications approved in roughly one week once all required information is submitted.

OPTION C: SUBMITTING A COMPETENCY PORTFOLIO

We also offer a route to membership via completing a competency portfolio. This is for those who are experienced in the avalanche industry but do not meet the requirements for Option B. Through this method, applicants show how they meet the competencies of an Avalanche Educator through a series of questions. This is currently only available for Basic Avalanche Educator membership. We aim to process these applications in under four weeks. The process for Advanced Avalanche Educator will be available in 2024.

MOVING FORWARD

These categories would not be possible without the CAA membership voting to approve them in the spring of 2023. Since then, the project team, Membership Services, and ITP staff have worked diligently in coordination with Avalanche Canada to bring the categories and courses that support them to fruition. We look forward to providing additional updates to the membership.

Making the Most of InfoEx Data

Karl Klassen

THE INFOEX ADVISORY COMMITTEE invited me to write an article to help InfoEx subscribers (especially those new to the system) efficiently enter information in a way that maximizes the effectiveness of the data. What follows is based on my experience as a practitioner who has used InfoEx since its inception, knowledge I've gained in data aggregation and visualization techniques while developing new software for Avalanche Canada, and my observations while training and mentoring guides and forecasters. These are largely my personal opinions, thus the first-person perspective, but I've incorporated feedback and input from IAC members to reflect a broader perspective than just my own.

OVERVIEW

InfoEx plays several roles. First, it's a data-sharing platform that helps the community better understand current real-world conditions. Subscribers use InfoEx to tell others what is happening in their area, interpret what's going on around them, and assess how conditions are trending over time. One of the most important aspects of InfoEx is the ability to see anomalies. Sometimes the outlier is more important than the average, in low probability-high consequence scenarios for example. InfoEx has a significant beneficial effect on professional decision-making, and it is the primary data source for Avalanche Canada's public avalanche forecasts.

InfoEx also contains the largest single database of professional level avalanche information in North America and possibly the world. If you count the paper records from before the time we had an electronic system, there's detailed, daily data from up to 120 or so subscribers starting in the late 80s. This is a treasure trove for current and future research.

Finally, while some operations have their own private applications in which they carry out their day-to-day risk management workflows and record data, analyses, and forecasts; many subscribers who do not have the expertise or funding required to create their own software rely on InfoEx for daily workflows and data storage.

These use cases and the variety of use-case contexts mean InfoEx has a large suite of features that can be daunting, especially if you are new to the platform.

This article does not provide detailed instructions for all the various InfoEx functions. It's intended to offer some general guidance on how to enter data most efficiently in a way that maximizes the effectiveness of using InfoEx in your operation, as well as making data more useful to the whole community.

MINING THE DATA

As we all know, a data-sharing system only works if everyone participates. In addition to simply contributing, we can maximize the effectiveness of InfoEx by entering data in a structured way so it's easy for us and our colleagues to access and use.

Whether in our brain or using a software application, to efficiently and effectively get to relevant information on any given day, we have to be able to quickly and easily separate the gold from the gravel. To do this, we use visualization tools such as map overlays, tables, charts and graphs. What we see in these visualizations is determined by the sorting or filtering functions that have been applied to the data. For example: "Show me all skier-triggered, persistent slab avalanches, size two or larger, within 50 km of my location."

InfoEx offers various sorting, filtering, and visualization tools, but they may not be obvious, especially if you are new to InfoEx. Familiarization and experimentation with things like adding and removing columns from reports, sorting the data in report tables, and customizing map overlays can greatly enhance your use of InfoEx data.

GENERAL VS. DISCRETE DATA

There are two broad data entry options in InfoEx. General text consists of unstructured written entries (e.g., snowpack summary, avalanche summary). Discrete data is entered by picking from preset selections using things like dropdown lists, checkboxes, and radio buttons.

Generalized data is well suited to conveying ideas, concepts, and analysis. The more structured discrete data, largely based on *Observation Guidelines and Reporting Standards for Weather, Snowpack and Avalanches* (OGRS), is a more effective format for quickly sorting, filtering, and visualizing specific data on the map, in tables, or with charts.

In my experience, many practitioners feel discrete data entry is not worth the time and energy, leading to a tendency to submit written text or aggregated observations. This approach limits the ways we can search for and see the data that's important. The less discrete data there is, the less effective our data visualization, search, and filtering tools are, which makes it harder to grasp the big picture while still being able to quickly drill down to the relevant details. And without discrete data, it becomes very difficult to see historical trends over time.

AN EXAMPLE OF NEW-SCHOOL DATA VISUALIZATION

Let's use avalanche observations as an example. If you enter only an avalanche summary in a text box, it's difficult to show that information on a map, find and sort or filter it in a table, or chart it so we can see trends over time. Entering individual avalanches in the avalanche observations form makes it easier to produce customized, relevant geospatial views, tables, or charts that show you the current situation and trends.

While I understand the time constraints, and I'm not suggesting every single avalanche needs to be entered as a single av ob, entering more discrete data, especially when you see something notable (think anomaly), will allow better

FIG. 1: VISUALIZATION FROM AVCAN'S AVOBS DASHBOARD PROTOTYPE HIGHLIGHTING DEEP PERSISTENT SLABS BY TRIGGER, SIZE, ASPECT, AND ELEVATION OVER TIME AND SPACE. THIS REPORT REQUIRED LESS THAN A MINUTE TO CREATE. THIS KIND OF VISUALIZATION IS ONLY POSSIBLE WHEN DISCRETE AVALANCHE DATA ARE REPORTED IN INFOEX.

visualization of the information. This is not some distant future development—Avalanche Canada has already built a beta avalanche observations dashboard with new and powerful visualizations.

In the Fig. 1 above I've shown a new approach to avalanche observations, but similar ideas are being planned for visualizing other data such as weather, field summaries, avalanche problems and hazard, and more.

IDEAS FOR MORE EFFECTIVE TEXT

Don't get me wrong, there's a lot of value in textual data, and in some cases (e.g., snowpack summary) there's no other option at this time. But it's much harder to find the gold in this written information because of the lack of structure. Text fields are more or less a free-for-all where you can write whatever you want, in any order, using whatever jargon you prefer.

I suggest some self-imposed guidelines for structuring textual data that will significantly help us all find and use it more effectively. This is certainly true in the current era, when we still have to read through and parse each text field manually. When we eventually do build tools and functions that allow us to better sort, filter, and visualize textual data (AvCan is already starting to work on this), some standardization in how we write our text will be very useful.

Here are some thoughts on how to make your textual data more effective and easier to understand.

IN ALL TEXT FIELDS

Familiarize yourself with the OGRS standards for describing various data and use those in your text entries. For example, when reporting sky condition, either write out the word or use the data code if you want to shorthand your entry. DO use "Obscured" or "X" which are OGRS compliant, but DO NOT use OBS, which is not.

ATTACHMENTS

Using attachments to provide visual information can significantly add to the richness and value of a report. For example, photos of avalanches can illustrate in a single stroke what would take several sentences to describe in an avalanche summary text field.

In many cases, attachments can save you a lot of time and effort. For example, if you attach an OGRS compliant PDF or image of a drafted snow profile you may not have to write up a highly detailed textual snow profile entry.

AVALANCHE SUMMARY

Use the avalanche summary section to describe the big picture or avalanches that are of little or no concern. For example:

In the Purple River drainage, evidence of a widespread cycle of small wind slabs that occurred during last week's wind event, these were in the Alpine, on NE, size 1. Isolated, size 1 wind slabs, stubborn but still skier triggerable if you work at it on steep, unsupported features at Treeline. One notable deep persistent slab in the last 24 hours—see avalanche observations. No recent or new activity below treeline.

SNOWPACK SUMMARY

Order your summary comments starting at the top of the snowpack and working your way down to the ground.

- "Surface" describes the current surface.
- "Upper" describes the upper pack, which is the snow from the most recent snowfall event(s).
- "Middle" is older snow below the upper pack.

- "Deep" is early-season snow that lies at and above the ground.

For example:

Surface: Alpine and treeline breakable IFsc 2-4 cm thick on all solar terrain, DF on shaded aspects. Below treeline SH size 4-6 on shaded, sheltered areas and 10-12 cm IFsc carries skiers on solar aspects.

Upper: HST from 3 days ago has settled from 40 cm to 30 cm and is now a mix of PPsd size 4-5 and DF size 2-3. No sign of instability and bonding well to mid-pack.

Mid: Well settled and firm RG size 0.5 and smaller. No significant concerns except, this lies on the early Nov. IFrc/FC combo which is the boundary between the deep and mid-pack.

Deep: Early Nov. IFrc/FC (still producing hard SP test results see details in Snow Profile report) lies on a mix of FCxr size 3-4 and DHxr size 6-8, which are settled and bonded into a uniform 1F layer in which there are no concerns.

Don't include detailed snow profile or stability test information in your snowpack summary. If you carried out profiles or stability tests, describe the details in the Snow Profile section.

SNOW PROFILE

Use this section to describe profiles and test results. Create separate snow profile entries for separate locations. For example, if you did profiles on Run A, Run B, and Run C, create and submit three entries with the data from each run in their respective forms. The simplest way to do this is to attach images or a PDF of your field book page(s) or plotted snow profile, and summarize the most significant information in the observation. For example:

Run A: SE, 2250m, exposed, wind affected, low alpine feature with variable depth snowpack. HS 170.

CTH 21 (SP) down 130 in FC on IFrc (early Nov. interface), 1x3
CTH 25 (RP) down 130 in FC on IFrc (early Nov. interface), 2x3

See attached profile for details.

If you choose to write up your test results in the Snow Profile text field, some thoughts on structure are:

- Include a quick description of the location.
- Include HS whenever possible.
- Provide a brief overview of layering by describing layer depth/thickness and primary characteristics.
- Use OGRS standard language and abbreviations.
- Describe test result depths measured down from the surface.
- Indicate how many results and how many tests. E.g., one result out of three tests would be 1x3.

Remember, this is not a snowpack summary—this is detailed pit and/or test data from a specific location.

For example:

Run A in the Purple River drainage. SE, 2250m, wind affected, low alpine feature with variable depth snowpack.

HS 170.

Surface: FCsf 2mm.

0-10 cm: P+ wind crust

10-25 cm: 4F DF 2-3mm

25-130: P RG 0.5mm and smaller

130-135: FC 3mm on IFrc. This is the early Nov. interface. FC's still well formed and not rounding. Crust is starting to show signs of breaking down, mostly P+ to K with I lenses.

135-170cm: Mix of old FC and DH 4F+ to 1F, 3-4cm M snow at ground.

CTH 21 (SP) down 130 in FC on IFrc interface, 1x3
CTH 25 (RP) down 130 in FC on IFrc interface, 2x3

TERRAIN MANAGEMENT

This section is a mix of preset options and text. While there are no charts or geospatial visualization for this data yet, it would be an easy target for future improvements in moving beyond tabular displays of the data. I suggest using the preset menu selection options as much as possible. Use the text box to provide analysis or context that adds to the data selected from the menu items.

SUMMARY

I leave you with the following thoughts:

- Enter discrete data whenever possible so all of us can more effectively access and analyse the data that's relevant to us.
- Use a structured approach in free text entries. Even if the structure I propose isn't universally adopted, a standardized structure that's always used by everyone in your operation is beneficial.
- If you are completely against the idea of a structured approach to text entries, then something as simple as committing to using standardized OGRS terminology will help significantly.
- Familiarize yourself and experiment with InfoEx sorting and filtering options so you can create customized maps, tables, and charts that help you quickly and effectively visualize the data and find the gold.
- Avalanche Canada is developing tools that allow advanced visualization of various data in InfoEx as well as other sources. If you are interested in seeing what's available and trying out some of the prototypes, contact me: kklassen@avalanche.ca.

Fuse **News**

Chris Argue and Steve Brushey

AS THE 2023-24 winter ramps up, the Explosives Advisory Committee has been engaged on two key topics:

1. Proposed changes to the Explosives—Quantity Distances (QD) standard.
2. Transportation of Dangerous Goods (TDG) by air regulation.

Key points are discussed below.

EXPLOSIVES—QUANTITY DISTANCES STANDARD

For ski resorts with avalanche control programs, hillside storage regulation under G06-03 is once again front and centre. Proposed changes to QD would remove G06-03 and bring ski areas under the main standard. This includes treating ski runs as public traffic routes by equating skier volume to traffic volume, where two skiers are equal to one car. This would result in an increase in distances to ski runs with over 1,000 skiers per day (medium traffic) to the D5 distance (minimum 180 m).

According to preliminary information, ski lifts would also be treated as a medium traffic routes and be subject to the D5 distance. The CAA and Canada West Ski Areas Associations continues to work with members on the topic. At this time, the proposed changes are expected to be available for public consultation in the new year.

TDG BY AIR

Explosives are only permitted for transportation by air under two exceptions in the Transportation of Dangerous Goods Regulations (TDGR):

- Part 12.5 Forbidden Explosives, specifically Clause (1)(b), which lists specific explosives that are permitted; and
- Part 12.12 Aerial Work under Clause (1)(e).

By now, the membership should be aware TDG by Air training is required for helicopter control. This applies to all who handle or transport dangerous goods (unless they are an employee of the air carrier) [TDGR 12.12(3)(b)].

Documentation and notification requirements have also come to our attention. The transportation of explosives between locations without being deployed requires a shipping document [TDGR 12.2]. Transportation is defined as any time when explosives "do not have an active means of initiation and are not primed for use" [TDGR 12.5(1)(c)(iii)]. The shipping document, referred to as a Shipper's Declaration, must be completed in accordance with the requirements of the International Civil Aviation Organization, and it differs from TDG by Road shipping documents. Shipper's Declaration templates for dangerous goods are available on the International Air Transport Association's website.

Additionally, when transporting explosives under Part 12.5, the shipper is required to "notify the air carrier, in writing, of the shipping name, UN number, primary class and compatibility group of the explosives at least 48 hours" in advance, and the air carrier must provide "written agreement to transport the explosives" at least 24-hours in advance [TDGR 12.5(2) and 12.5 (3)]. This agreement is then "valid for any subsequent transport of the explosives for two years" [TDGR 12.5(4)]. Subsequently, each actual shipment requires completion of a shipping document.

During transportation under Part 12.5, remember shippers must comply with most other aspects of the regulations, including the requirements for an ERAP and the TDG by Air training for those who load, secure, handle or transport dangerous goods.

To be clear, when explosives are primed for deployment (i.e., for avalanche control), TDGR 12.12 applies, and no documentation is required unless the pilot-in-command **does not** directly supervise the loading of dangerous goods. In that case, a notice in writing of the shipping name, UN number, and net explosives quantity must be provided.

Part 12.9 Limited Access has come up in conversations in the past as an "exemption" from TDG training and documentation requirements. However, there are specific dangerous goods listed to which this section applies, and explosives are not included.

The information above is provided solely as information as we currently understand it and should not be taken as advice or direction. Members who are transporting explosives under Part 12.5 and/or performing avalanche control by helicopter under Part 12.12 **must** read and understand the regulations.

REMINDERS

The EAC has been notified that many members are not arriving at WorkSafe BC blasting exams with proper documentation of continuing professional development. WSBC requires that blasters receive at least six hours of continuing professional development relating to blasting best practices annually. This has been in force since December 2021, and anyone without this documentation may be denied the opportunity to write the exam. For more information, see WSBC's information sheet on CPD for blasting online.

In March 2023, WSBC published a new version of the *Blaster's Handbook*. It has many important updates on current best-practice and includes a dedicated chapter about avalanche control. A free download is available on WSBC's website.

Finally (yes, finally), as we begin another operational season, the EAC strongly encourages members to report any blasting- or explosives-related incidents via InfoEx.

We wish members the best in navigating this new information. Please reach out to us at any time on these or any other explosives-related topics.

ISSW 2026 Coming to Whistler

ISSW 2026 Committee

FRESH OFF THE 2023 International Snow Science Workshop (ISSW) in Bend, Oregon, and excited for 2024 in Tromso, Norway, the ISSW returns to Whistler, BC, Canada, in 2026.

Whistler was only recently awarded the next Canadian event and the local organizing committee has been hard at work in partnership with the Canadian Avalanche Association, and supported by Whistler Blackcomb (Vail Resorts) and the Avalanche Canada Foundation. The five-day event will take place at the Whistler Conference Center (WCC) and will include a field day for professionals and a public workshop. Evenings will be full of a variety of social events, featuring a public awareness fundraiser on the Wednesday and, of course, the final banquet.

We have secured the entire Aava Hotel at the best discounted rates in town as our primary accommodation for the week. Located only steps away from the WCC and Whistler Village, the Aava will provide delegates with a more immersed feel and opportunities to connect—think the Ramada at the CAA Spring Conference. We encourage everyone to book their stay early, park their vehicle for the week, and enjoy everything Whistler has to offer within walking distance.

With the conference being held in late September, attendees will also be able to take advantage of both Whistler and Blackcomb mountains, which will be open for sightseeing, hiking, and mountain biking in Whistler's world-renowned mountain bike park.

In keeping with the ISSW motto of, "Merging of theory and practice," our aim for this conference is to create more opportunities for snow and avalanche practitioners to present information about their practices, experiences and/or operations alongside some of the world's leading snow scientists.

ISSW 2026 will be offering different sponsorship levels and exhibition packages. Please contact us if you are interested.

We look forward to welcoming everyone from September 28 to October 2, 2026!

CO-CHAIRS:

Nicole Koshure – nkoshure@vailresorts.com
Tim Haggerty – thaggerty@vailresorts.com
Jerome David – jdavid@vailresorts.com

SCIENTIFIC CHAIR:

Scott Thumlert (Chair)
Simon Horton
Chris Argue
Curtis Pawliuk

// TIM HAGGERTY

Contributors

DAVID RICHARDS was raised in the Wasatch Mountains of Utah. He is the Director of the Alta Ski Area Avalanche Program where he has worked for 23 years. He has worked as a helicopter ski guide, an avalanche dog handler, and an artillery gunner, and is still active with backcountry search and rescue.

27 SCORING SNOW PITS

FRANCIS MELOCHE is a PhD student at the University of Québec in Rimouski (UQAR), under the supervision of Francis Gauthier and Alex Langlois from Sherbrooke University. He was also a visiting PhD student at the chair of Alpine Mass Movements with professor Johan Gaume at the SLF in Davos, Switzerland. His thesis focuses on the influence of spatial variablity of snow properties on skier triggering probability and avalanche size. He hopes to bring useful tools and knowledge to the avalanche practioners with his research.

32 MAPPING SNOW MECHANICAL PROPERTIES

PETER BARSEVSKIS is an industrial avalanche technician at Brucejack Gold Mine. His avalanche career began as a ski patroller at Kicking Horse Mountain Resort. In 2022, he completed his Master of Science at Thompson Rivers University, focusing on snow characteristics with the blade hardness gauge. His home is in the mountains of Golden, B.C., with his wife and dogs.

36 THE BLADE HARDNESS GAUGE

CAA Welcomes **New Staff**

JO KEENE, ITP LOGISTICS COORDINATOR

Jo has joined the CAA in the role of ITP Logistics Coordinator. Originally from the UK, she has been living in Revelstoke for six years and loving life in the mountains. When not organizing gear for the CAA, Jo works as a snowboard and ski instructor at Revelstoke Mountain Resort. She is excited to cultivate a new set of skills and discover a different side of the winter industry.

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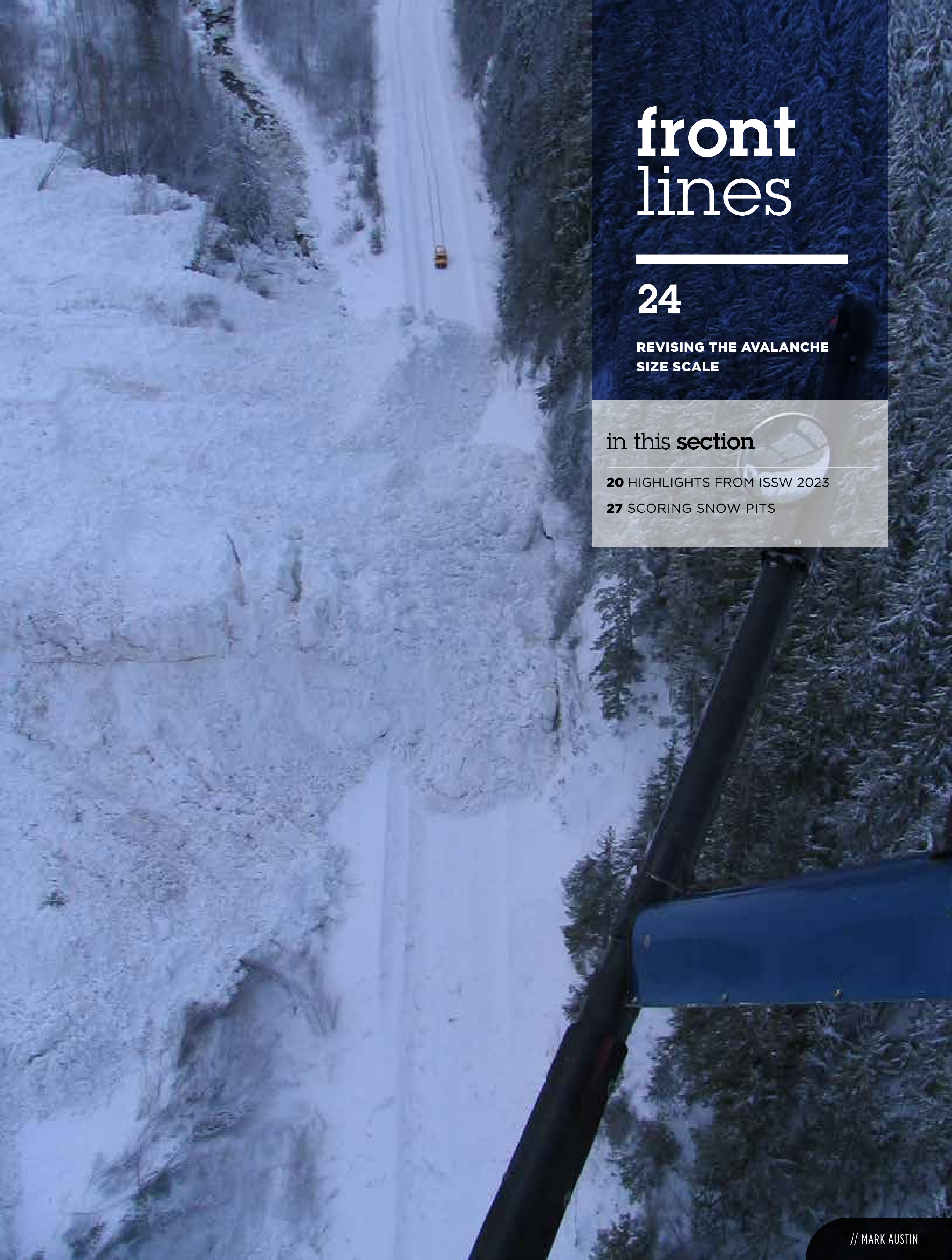


front lines

24 **REVISING THE AVALANCHE SIZE SCALE**

in this **section**

// MARK AUSTIN

Highlights from **ISSW 2023**

Alex Cooper

THE 2023 International Snow Science Workshop in Bend, Oregon, from Oct. 8–13 was a welcome return to in-person meetings for the global snow and avalanche community. More than 1,100 people attended, including a large Canadian contingent, who were well represented amongst the diverse roster of presenters and attendees.

We reached out to the many CAA members in attendance to hear about their highlights from ISSW. Here's what we heard back:

CAM CAMPBELL, SENIOR AVALANCHE SPECIALIST/ ENGINEER, ALPINE SOLUTIONS AVALANCHE SERVICES

What brought you to ISSW?

Professional development, networking, meeting new people, and catching up with old friends.

What was your biggest highlight(s) from this year's ISSW and why, whether it was a presentation, poster session, or simply a conversation you had with someone in the exhibit room?

Reuniting with the UofC ASARC alumni (there were 10 of us, plus Bruce), some of whom I haven't seen since the last in-person ISSW in Innsbruck.

What is something you learned from our American and European counterparts that you'd like to share with CAA members?

I am always jealous of the historical records that Europeans have available for analysis. There is a lot less uncertainty when you have—in some cases—centuries of data to work with.

CHRIS ARGUE, AVALANCHE SPECIALIST, DYNAMIC AVALANCHE SOLUTIONS

What brought you to ISSW?

A few things I was looking forward to at ISSW this year:

- Within our team, we had some specific questions for European practitioners about avalanche hazard assessment methods. The discussions we had with experts from Norway and Switzerland were very informative.
- I have recently been interested in collaborating with practitioners from other geohazard disciplines such as landslides and rockfalls. We are not the only sector that thinks about 'stuff falling down mountains,' so it's been interesting to see how others assess this problem. I was excited to have the opportunity to collaborate with landslide and rockfall experts to present a paper and poster at this ISSW outlining a method to assess risk from multiple geohazards, including snow avalanches, within a common framework.
- The newly formed, U.S.-based group RACUNAC (Remote Avalanche Control System Users of North America) held its first meeting. It was insightful to hear about regulatory and technical challenges faced by American RACS users.
- Catching up with colleagues from the U.S. and Europe after a five-year break from in-person ISSWs!

What was your biggest highlight(s) from this year's ISSW and why, whether it was a presentation, poster session, or simply a conversation you had with someone in the exhibit room?

- The opportunity for discussions with other practitioners in the poster/exhibition hall and over lunches and dinners was the highlight for me.
- Ethan Greene's review of the 2019 avalanche cycle

DR. ALEC VAN HERWIJNEN PRESENTS OUTSIDE ON THURSDAY MORNING AFTER A WIDESPREAD POWER FAILURE CAUSED BY A SQUIRREL (TRUE STORY) INTERRUPTED PROCEEDINGS. THE ISSW ORGANIZERS QUICKLY ADJUSTED BY MOVING THE POSTER SESSION AND PRESENTATIONS OUTDOORS UNTIL POWER WAS RESTORED. VAN HERWIJNEN IS A GRADUATE OF THE UNIVERSITY OF CALGARY'S APPLIED SNOW AND AVALANCHE RESEARCH CENTRE AND IS NOW THE LEADER OF THE AVALANCHE FORMATION GROUP AT THE WSL INSTITUTE FOR SNOW AND AVALANCHE RESEARCH SLF IN DAVOS, SWITZERLAND. // ALEX COOPER in Colorado was a big highlight both for practitioners, planners/engineers, and researchers. It's rare to get such good perspective on widespread, long-return period avalanches.

What is something you learned from our American and European counterparts that you'd like to share with CAA members?

I learned some alternative applications or methods that could be considered for hazard/risk assessment from some discussions with and presentations from European practitioners.

MIKE CONLAN, AVALANCHE FORECASTER, AVALANCHE CANADA

What brought you to ISSW?

I've attended ISSW since 2012 and quickly realized the immense benefit of attending. It hosts many of the leaders in the international avalanche industry and provides a venue for learning the latest research and knowledge. Invaluable discussions occur at ISSW to keep your knowledge current and to think about future ideas.

What was your biggest highlight(s) from this year's ISSW and why, whether it was a presentation, poster session, or simply a conversation you had with someone in the exhibit room?

Seeing friends and colleagues from over the years is one of my favourite aspects of ISSW. Reminiscing, discussing current work, and brainstorming future endeavours make these face-to-face events worth it.

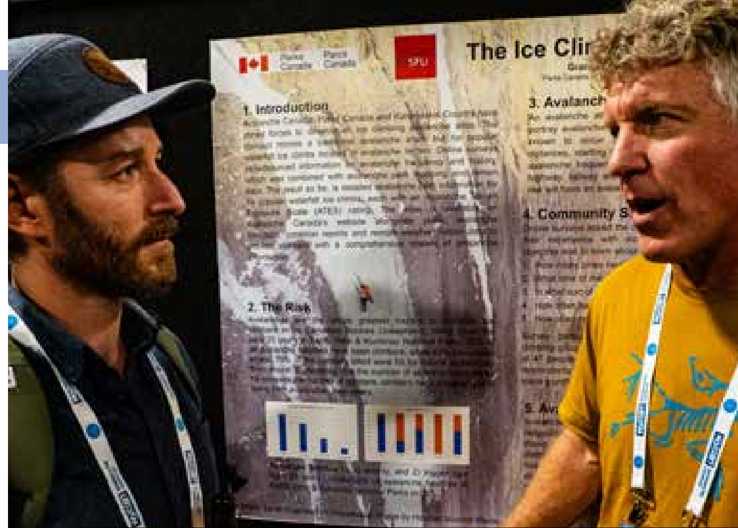
What is something you learned from our American and European counterparts that you'd like to share with CAA members?

Researchers and practitioners in other countries are working on fascinating and important studies on physical snow and avalanche science, such as improving our understanding of fracture propagation, avalanche dynamics, and the usefulness of snowpack tests. The conference also brought to the forefront what we may see in the future with climate change: more wet avalanches, shorter seasons, but still periodic high-snowfall weather events that could lead to historic avalanche cycles.

NANCY GEISMAR, EDUCATION & OUTREACH COORDINATOR, AVALANCHE CANADA.

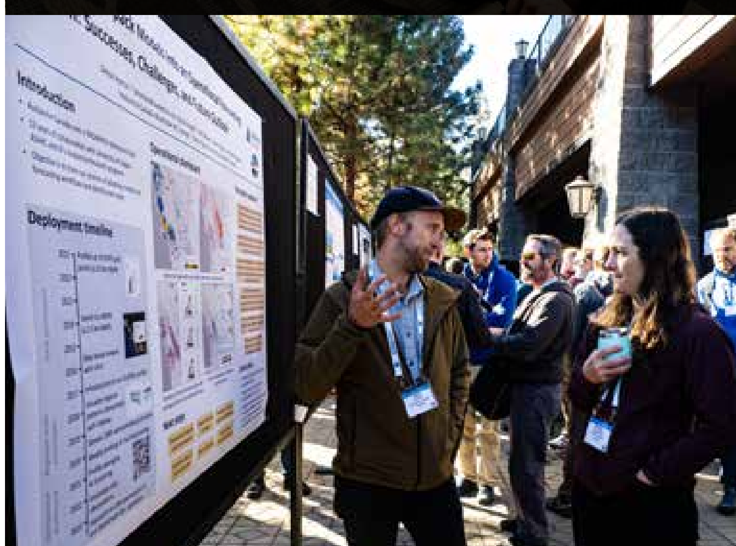
What brought you to ISSW?

I really wanted to be a part. It's an exciting event. I look forward to interacting with different folks and sharing some of what we do at Avalanche Canada.



DR. AUSTIN LORD (LEFT) TALKS TO GRANT STATHAM DURING TUESDAY'S POSTER SESSION. LORD IS AN ANTHOPOLOGIST AND POSTDOCTORAL FELLOW AT UNIVERSITY OF TORONTO'S SCHOOL OF THE ENVIRONMENT. HE PRESENTED HIS RESEARCH ON THE PEOPLE OF LANGTANG RECOVERED FOLLOWING THE APRIL 25, 2015, AVALANCHE THAT KILLED OVER 300 PEOPLE AND WIPED OUT THEIR MAIN VILLAGE. IT WAS A EVOCATIVE PRESENTATION THAT STOOD OUT AT ISSW FOR ITS CULTURAL LOOK AT AVALANCHES AND RECOVERY. STATHAM PRESENTED ABOUT ATES 2.0 AND THE ICE CLIMBING ATLAS. // ALEX COOPER

ANNE ST. CLAIR, A PHD CANDIDATE WITH SIMON FRASER UNIVERSITY'S AVALANCHE RESEARCH PROGRAM WAS RECOGNIZED AS AN AVALANCHE DIVA AT ISSW 2023. HERE, SHE PRESENTS HER POSTER ON WORK LOOKING AT THE EFFECTIVENESS OF PUBLIC AVALANCHE SAFETY SERVICES. // ALEX COOPER



SIMON HORTON, A FORECASTER AND RESEARCH OFFICER WITH AVALANCHE CANADA, DISCUSSES HIS POSTER ON THE OPERATIONAL USE OF SNOWPACK MODELS WITH BRIDGET MACMURRAY OF PARKS CANADA DURING THE SURPRISE OUTDOOR POSTER SESSION CAUSED BY A WIDESPREAD POWER FAILURE THURSDAY MORNING. // ALEX COOPER

What was your biggest highlight(s) from this year's ISSW and why, whether it was a presentation, poster session, or simply a conversation you had with someone in the exhibit room?
There were many presentations I enjoyed: the session on Monday on decision-making and especially the panel discussion on "Digital Tools For Recreational Avalanche Risk Management." I also really enjoyed the Decision Making session on Tuesday, and the session on Thursday on Avalanche Education. Probably none of that is surprising.

Pascal and his students' work is always very informative and instrumental for AvCan. They are doing good work on the human factors/social science connection with avalanche education, and how we can best target our users with knowledge and resources. I'm very grateful to the SFU folks for their research and sharing.

What is something you learned from our American and European counterparts that you'd like to share with CAA members?
A highlight was gathering with the U.S. motorized instructors to talk about the challenges of getting more motorized users taking courses (especially AST 2/AIARE 2). There were good conversations and it was a great opportunity to rub elbows with "others."

NATA DE LEEUW

What brought you to ISSW?
I attended ISSW for the opportunity to be in the same room as so many interesting, smart, and creative people from throughout the avalanche world, and to keep up with the newest conversations and research developments.

What was your biggest highlight(s) from this year's ISSW and why, whether it was a presentation, poster session, or simply a conversation you had with someone in the exhibit room?
I felt such a sense of community at ISSW, and this was the highlight from my perspective.

What is something you learned from our American and European counterparts that you'd like to share with CAA members?
I am really interested in some of the avalanche mechanics research from SLF. It was cool to learn about existing methods for measuring, estimating, and modelling crack propagation speed, and how this relates to avalanche size.

NICOL KOSHURE, AVALANCHE FORECASTER, WHISTLER BLACKCOMB

What brought you to ISSW?
I came to ISSW 2023 in Bend hoping to broaden my knowledge of snow and avalanche science and to learn from other practitioners in the avalanche industry.

What was your biggest highlight(s) from this year's ISSW and why, whether it was a presentation, poster session, or simply a conversation you had with someone in the exhibit room?
My biggest highlight was the opportunity to meet and develop face-to-face relationships with other avalanche practitioners working in our industry. As a Co-Chair for the ISSW Whistler 2026 organizing committee, this was also a good opportunity to network with sponsors, scientists, and practitioners, and to discuss how to make Whistler 2026 a great event!

What is something you learned from our American and European counterparts that you'd like to share with CAA members?
There is lots of interesting work going on to develop models that can be used to help forecasters use numerical tools to help generate forecasts for their area. This can be especially useful when trying to track and manage persistent weak

GRADUATES OF DR. BRUCE JAMIESON'S APPLIED SNOW & AVALANCHE RESEARCH CENTRE REUNITED AT ISSW. FROM LEFT: DAVE GAUTHIER, ALAN JONES, GREG JOHNSON, ALEC VAN HERWIJNEN. SCOTT THUMLERT, CAM CAMPBELL, MIKE CONLAN, SIMON HORTON, RYAN BUHLER, AND JAMES FLOYER. DR. JAMIESON IS KNEELING. // CAM CAMPBELL.

layers or wet snowpack instabilities (e.g., work by Binder and Mitterer, Perfler et al. in Europe; or by Florian Herla and the SFU Avalanche Research Group in Canada).

WREN MCELROY, NORTH CASCADES DISTRICT AVALANCHE SUPERVISOR, BC MINISTRY OF TRANSPORTATION & INFRASTRUCTURE

What brought you to ISSW?

I was excited to connect with avalanche professionals from all over the world, in particular from the transportation and industry sectors.

What was your biggest highlight(s) from this year's ISSW and why, whether it was a presentation, poster session, or simply a conversation you had with someone in the exhibit room?

My biggest highlight was connecting with members of the American Avalanche Association.I was very impressed with the way the Americans are working hard and are so progressive in all areas of research, planning, forecasting, implementation, education resiliency, and more. Other highlights include:

- connecting with members of departments of transportation in the States and attending the Transportation Avalanche Research Pool meeting;
- connecting with Dr. Laura McGuire, who presented on mental models and human factors;
- and, of course, the Diva night and AAA after-party!

What is something you learned from our American and European counterparts that you'd like to share with CAA members?

- Modelling used to make my eyes roll back a little and many people groan at the thought of modelling, but the science is definitely getting more reliable and showed up in many areas of ISSW.
- Climate and avalanches
  - Climate change was tied to many ISSW papers and there was great information on climate and avalanches, with very interesting work on dendrochronology and avalanche chronology, including studies going back to 1695.
- Planning and engineering
  - Operational road and railway work by Hamre et al. re-analyzing the Avalanche Hazard Index. It was an Interesting look at this. They used Peter Schearer's method and presented on the updated method.
  - Data driven RACS placement in Alaska.
- Jurg Schweizer's dictionary of terms for avalanche forecasting.
- Karl Birkland's comparison of snowpack tests.
- Dr. Laura McGuire's recalibration of human factors.
- Laura McGladrey's work on resiliency.

ANNELIESE NEWEDUK PRESENTS ON HER MASTER'S RESEARCH ON BACKCOUNTRY USERS DURING THE TUESDAY AFTERNOON SESSION ON DECISION-MAKING. NEWEDUK IS A RECENT GRADUATE FROM SARP AND WAS A RECIPIENT OF THE YOUNG PROFESSIONAL AWARD FOR AVALANCHE RESEARCHERS AND PRACTITIONERS UNDER THE AGE OF 30 WHO PRESENTED AT ISSW. // ALEX COOPER

SCOTT THUMLERT PRESENTS TO A PACKED ROOM ON HOW GUIDES AT CMH MANAGED THE DEEP PERSISTENT SLAB PROBLEM DURING THE 2022-23 SEASON. // RYAN BUHLER.

Revising the Avalanche Size Scale

An interview with Tyler Carson on proposed revisions to the Canadian avalanche size scale

Alex Cooper

THE CANADIAN AVALANCHE SIZE SCALE was introduced in 1981 by David McClung and Peter Schaerer . They developed a system to report avalanches on a scale of one to five based on their path length, deposit size, run length, and destructive potential. In recent years, a group including Tyler Carson, Bruce Jamieson, Lisa Larson, and Brendan Martland have been working on revisions to the avalanche size scale. They presented their ideas at the 2023 CAA Spring Conference, then conducted a survey of avalanche professionals over the summer. Tyler then presented an update at ISSW 2023 in Bend, Oregon.

Their proposed update maintains the five-level scale, but adds deposit volume as a measure of avalanche size, and changes several of the descriptors of destructive potential. I spoke to Tyler, the Snow Safety Supervisor at Fernie Alpine Resort, about why they feel the size scale could use an update and the work he and his group have done to this point.

(Note: this interview has been condensed for space and edited for clarity. To view the full interview, visit avalanchejournal.ca.)

Alex Cooper: Where did this idea to review the size scale originate and what's been the process so far?

Tyler Carson: I think originally it started with Bruce (Jamieson), Montse (Bacardit Penarroya), Ethan Greene, and Ian Tomm's work back in 2020, where they were giving a more visual method of estimating avalanche size. From there, it went to a presentation Bruce gave at the Elk Valley Snow Avalanche Workshop, where he talked about this more visual method of estimating avalanche size, and whether different observers give different sizes of avalanches.

And then it moved on to our presentation at the spring meetings, where we discussed whether we should include escape skill and terrain traps into the size scale to allow for better estimation. And then on to ISSW, where we presented a paper about how there are two different things that really affect how people make estimations of avalanche size, how they can be inconsistent, and some ideas on how to make it more consistent.

What do you see as the issues with the current scale?

I think the current scale doesn't provide enough tools for practitioners to provide good estimations of avalanche size. We're getting a discrepancy in size due to a lack of tools and a lack of clarity of language, is really what it is. Currently we do have a few issues with the actual volumes and measures of sizes, but what we're really trying to tackle here is how we communicate them and how we give people the tools to communicate them.

OK. You mentioned people are talking about size in different ways. What are some ways that people might overestimate or underestimate avalanche size?

We're often affected in our estimation of avalanche size through emotional response. If I've been caught in an avalanche or exposed to an avalanche, I may overestimate its effect just because of my personal fears, my stressors.

We also tend to over or underestimate due to our workplaces and the frameworks we work within. So, we can over and underestimate that way. When we're on foot and we get caught in an avalanche, we tend to overestimate. But then when the perspective is changed and we're in a helicopter or at a distance, we often tend to underestimate. So, trying to give people some tools to help with that, I think would make a difference.

Why is it important to get the size right? Why is that so important to communicate properly?

It's important to communicate properly and accurately because it's a tool. When we talk about size of avalanche within the Conceptual Model of Avalanche Hazard, we need to understand what is out there. We can't apply risk treatment appropriately if we don't understand what the actual size is that we're facing is. So, that's one of the biggest ones for me.

I have a very diverse group of coworkers and some of the newer workers—and some of the more experienced workers—have their own biases to avalanche size. Because I personally know them, I can adjust for their bias. But if I was being communicated to by somebody else that I didn't know, maybe another team somewhere else, or if I'm reading the InfoEx, I don't know that team or that group's bias.

You presented a couple of drafts of your proposed scale—first at the Spring Conference, there was more feedback received after that, and then you presented it again at ISSW. Can you talk about some of the elements of that the draft you've proposed. I'm interested in some of the new descriptors you had for some of the sizes. Looking at size one avalanches, it says, "Relatively harmless to a person on foot, unlikely to bury a person except in runout zones with unfavorable terrain features."

How did you come up with that descriptor?

That descriptor came from some discussions we had. The "on foot" we added because we want to help people to visualize someone at their highest vulnerability. When you're on skis or on your snowmobile, you are more vulnerable than you are when you're in a snowcat, for example, but you are less vulnerable than you are when you're on foot. As a human being, being on foot in avalanche terrain is your highest level of vulnerability. Hanging from ice tools is right up there, too.

The other descriptors that came along with the unfavorable terrain came from the European Avalanche Warning Service and from their descriptor. We've since readjusted and re-tweaked that. We found it was a bit wordy and we've taken big chunks of that out, and left some of the parts that we felt were important to the structure of that in.

OK. So, what wording did you use instead?

For draft two, we've gone to, "Relatively harmless to a person on foot except in terrain traps." Just cleared out a whole bunch of stuff.

OK. So the terrain traps being the main thing, which is something that I feel they teach in AST courses—a size one isn't harmless unless you get swept into a gully or over cliff.

Yeah. Our discussions on this really have come from the fact that it's really hard for people to grasp "relatively." Relatively is a funny word for people. When we say "relatively harmless," people automatically think harmless, and it's not harmless. It's just less harmful than a size D2 avalanche, which is something we have a hard time grasping.

For size one, you mentioned a person on foot. Same with a size two avalanche, you specify it "could bury or kill a person on foot." That "on foot" addition is not part of the scale now. I wonder—compared to people on skis or snowmobiles—where does the part about being on foot differ and why add that in?

Just the poor mobility. On skis, we can move fast. Even with your skins on, you can move faster than post-holing. If you're on skis or a snowmobile, you tend to be active in the terrain and know what's going on. Whereas, if you're an industrial worker who is outside of your bulldozer, you may not know how to avoid or move so that you can reduce your exposure to avalanches, or even be able to for that matter. So, being on foot, I think we're just really trying to get across that it is at their highest level of vulnerability.

Yeah. And then jumping ahead, for size three and four, I see the draft descriptors are largely the same. But for size five, you propose removing the phrase, "largest snow avalanche known." Why take that out?

The "largest size snow avalanche known" tends to bias people. They don't want to use it because you see a big avalanche and you're like, "Oh, is this the largest snow avalanche known or the largest one I've ever seen?" It may or may not be. But what it is, is the size five avalanche fits within a descriptor of size, of impact pressure, mass, volume, those sorts of things. And we want to make sure that people are making that decision that this is a size five avalanche by using those descriptors, and being able to estimate that and not going, "This isn't the largest snow avalanche known."

Mark Grist and crew gave a great presentation talking about it and how it's hard to say it's a size five. Johann Slam has lots of opinions on this and I've had some good conversations with him, where he's just like, "Yeah, it's a size five." And I think we just need to be able to more readily put that measure on an avalanche.

Yeah, I think it's a good point because I suspect the largest avalanches people experience in the mountains of Western Canada are not close to the scale of the largest avalanches known, which are massive, glacial, rock, snow, and ice events.

Size and Data Code	Damage Potential	Typical Mass	Typical Deposit Volume	Typical length	Typical Impact Pressure
D1	Relatively harmless to a person on foot. Unlikely to bury a person, except in run out zones with unfavourable terrain features (e.g. terrain traps)	< 10 t	Avg. apartment. ≤ 1 m	< 10 m or City Bus	1 kPa
D2	Could bury or kill a person on foot.	10^2 t	Floor of a large house ~2 m deep	100 m or a Soccer field	10 kPa
D3	Could bury and destroy a car, damage a truck, destroy a wood-frame house, or break a few trees.	10^3 t	Hockey rink 2-3 m deep	1 km	100 kPa
D4	Could destroy a railway car, large truck, several buildings, or a forest area of approximately 4 hectares.	10^4 t	4 Hockey rinks 4 m deep	2 km	500 kPa
D5	Could destroy a village or a forest area of approximately 40 hectares.	≥ 10^5 t	5+ Soccer fields 8 m deep	3 km	1,000 kPa

TABLE 1: A DRAFT SCALE FOR MORE CONSISTENT RATING OF DAMAGE POTENTIAL.

FIG 1: VIEWED FROM THE DEPOSIT, THIS AVALANCHE (SAME AS RIGHT PICTURE) MIGHT BE RATED AS SIZE D2. PHOTO BEN BRADFORD. THE SAME AVALANCHE VIEWED FROM A HELICOPTER, MIGHT BE RATED AS SIZE D1. PHOTO TYLER CARSON.

Yeah. You were at the ISSW with me and you saw the presentation from Langtang . The snow didn't melt from that village for four years, I think is what (Austin Lord) said. So, yeah, that's how deep and thick that avalanche was.

Yeah, for sure.

And then you're adding volume and volume descriptors to the scale. I was interested why you're adding volume and also how you came up with these descriptors such as, "Fill the floor of a large house two metres deep."

That's all Bruce, Montse, Ian and Ethan. We really just took that information and placed it in there, and then we have tried to tweak it a bit. There has been some concern about equity and about how people don't understand what a hockey rink looks like, or what an apartment looks like. You know, there's a mismatch there.

And these are just ideas really, where we're trying to find the best possible. We've discussed how maybe adding a glossary where it says, "Two tennis courts is a hockey rink," or something—some sort of equivalency scale so we can paint the best picture for all the people. And the volume descriptors are a good one because it's an easy one to visualize, right? It's hard to visualize mass. You've had a rain-on snow-event and you've had a dry snow avalanche. The piles will often be the same, but the masses will be different, and so estimating the mass might be tough. Giving someone another option to look at it doesn't have to be perfect. It may not be a perfect measure, but giving people a tool to look at the avalanche and go, "OK, the volume here should be a size two, or it should be a size three." It's just giving people more tools so we can hopefully be more consistent.

One thing about the size scale is it's used both by professionals to communicate with each other, but it's also a public communication tool. Is that a challenge figuring out how to make this work for professionals and recreationists?

I think that it is a challenge. It's definitely front of mind for all of us because it is a scale that is shared between recreationalists and workers. The difference between an experienced recreationalists and a new or young worker, it's a very grey zone. It needs to be available and usable by someone who is brand new, and by someone who has tons of experience, period, whether they're a professional or a worker or a recreationalist.

You've presented this now a few times and done several revisions. Where do you go from here?

We are in the refinement stage of where we're going with our size scale. The timing seems to be good. OGRS is due for revision here. We're going to submit it to the CAA Technical Committee and then allow them to review. We've decided we're going to leave the actual physical dimension measures of avalanches, whether it's mass, volume, those sorts of things, to those guys. They can research it and deal with that.

We're worried more about making sure our estimation wording alignment is as close as possible. I had a talk with Scott Thumlert about where to go next with this. We're going to try and move this forward in the next couple of weeks to him and pass it on to them, and then be there if they have questions for us. And hopefully it makes a difference. And if not, we've made an attempt.

Is there anything else you'd like to say?

If anyone has any feedback, feel free to e-mail me: tcarson@skifernie.com. Reach out to Bruce, Lisa, or Brendan, any one of us, and we'll take any and all feedback. You know, you get some real rogue stuff out there, but sometimes it makes lots of sense and sometimes it's something you've never even thought of.

What's the Score?
Scoring snow pits for better communication of stability assessments

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INTRODUCTION

Snow pits can often leave practitioners in a quandary—there just isn't a succinct and efficient method to communicate findings to one's peers. This makes it challenging to relate relevant snow pit information to new riders, students, ski patrollers, and even one's most experienced coworkers. Though we may understand snow pit data and what it tells us about the snow stability, communicating those findings quickly and succinctly is problematic. Our proposed method aims to simplify and improve communicating the most relevant data. As a caveat, our scoring system applies only to dry slab avalanche conditions.

Though some practitioners previously viewed snow pits solely as a forecasting tool, the advent of newer testing methods has given us improved stability assessments and allows pits to be used as a now-casting tool. Sharaf and McCammon (2005) first looked at snow pit information through the lens of "strength, structure and energy," rating each factor as good, fair, or poor. Many practitioners continue to use this method, and it is now taught in the Level 1 curriculum; though "propagation propensity" has replaced "energy," since propagation can be indexed with modern stability tests while energy has a clear physical meaning that is not captured in a typical snow pit (Fig. 1).

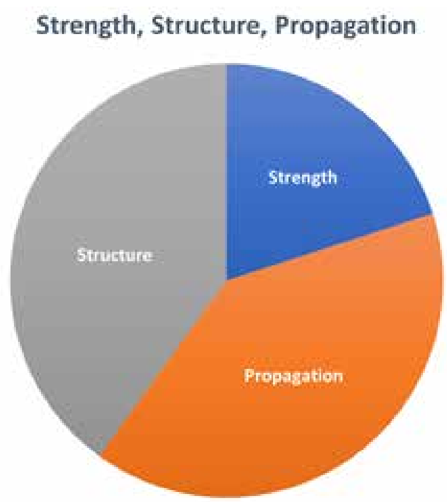

FIG. 1: SNOW STRENGTH, STRUCTURE, AND PROPAGATION PROPENSITY ALL CONTRIBUTE TO ASSESSING SNOW STABILITY.

We prefer the nomenclature of strength, structure and propagation—three things everyone can see and interpret, and that require only a hand, a shovel, and an extended column test (ECT) cord to measure. Further, these three factors can easily be given a score. The sum of these scores can allow us to communicate snow pit findings in comparison to overall stability. This is preferable to saying, "So what?" or "Looks good to me."

METHODS

Scoring pits

Researchers have assessed the utility of stability tests using methods that rate slopes as either stable or unstable (e.g., Simenhois and Birkeland, 2009). However, the shortcoming of these techniques is that stability is not strictly binary. Techel et al. (2020) developed a more nuanced approach based solely on observed signs of instability and used that to better identify how well specific tests assessed stability.

Our proposed snow pit scoring technique, dubbed the Grom Score, sums up numerical scores for strength, structure, and propagation propensity (Fig. 2). Propagation propensity is scored using ECT results, strength is scored with the number of ECT taps, and structure is assessed by a simplified version of the five lemons (McCammon, and Schwiezer; 2002) called the PHD factors (persistent weak layer/hardness change/depth of the weak layer) of snowpack structure.

We feel any scoring system should emphasize structure and propagation more heavily than strength, which can vary dramatically over short distances. In our scoring system, we give additional weight to structure and propagation by scoring them on a scale of 0–3 rather than the 1–3 scale we use for strength, and by applying the following three rules:

- If a PWL exists, then structure score ≤ 1
- If ECTP, then structure ≤ 1
- If ECTPV, then structure score = 0

In our method, structure is scored using the three simple PHD factors. Is there a persistent weak layer (PWL)? Is there a hand hardness change of one step or greater? Finally, is the depth of the weak layer less than one metre? The PHD factors are the simplest method of scoring snowpack structure and are often taught in modern Level 1 curricula.

	Rating	Description	Score
Strength	Difficult	Tap score 21-30-ECTX	3
	Moderate	Tap score 11-20	2
	Easy	Tap score 0-10	1
Propagation	ECTX	ECT provided no failure	3
	ECTN	ECT provided no propagation	2
	ECTP*	ECT provided full propagation	1
	ECTPV*	ECT fails with full propagation on isolation	0
	* If ECTP structure ≤ 1		
	* If ECTPV structure = 0		
Structure	Good	Weak snow on top of strong snow, lacking a weak layer	3
	Fair	Strong snow on top of weak snow, greater than a meter deep and lacking a PWL	2
	Poor	Strong snow on top of weak snow, PWL is present	1
	Very Poor*	All lemons or PHD factors are present with PWL	0
	*If PWL than structure ≤ 1		
		Total Score =	

FIGURE 2: THIS TABLE SUMMARIZES HOW PITS ARE GIVEN A GROM SCORE BASED ON SCORES FOR STRENGTH, PROPAGATION POTENTIAL, AND STRUCTURE.

Discussions with many avalanche professionals about our proposed scoring system raised several questions and arguments. First, should propagation and structure be weighed more heavily than crack initiation? This is a valid criticism, because if a crack cannot be initiated, then there is no avalanche. However, while crack initiation with the ECT is difficult when a weak layer is deeply buried, that same weak layer may be buried more shallowly at other locations on that slope due to spatial variability.

Second, several studies note ECT propagation alone cannot perfectly discriminate between stable and unstable slopes (Simenhois and Birkeland, 2006; Moner et al., 2008; Simenhois and Birkeland, 2009; Winkler and Schwiezer, 2009; Techel et al., 2020). While this is true, research also shows propagating ECT results are more often associated with unstable conditions (Techel et al., 2020). Therefore, when propagation in an ECT is present, our scoring method weighs it heavily.

Finally, some people argued structure trumps all. We agree this is true when the weak layer is deeply buried, which is why our method scores the structure of any snowpack with a PWL as less than or equal to one.

At first glance, our method appears to score snow pits with more stable snow higher than those with less stable findings. For example, a 150 cm deep pit with a faceted weak layer at 90 cm and an ECTP 17 at that weak layer would score a four. This clearly indicates a situation with low stability. Another pit on a nearby slope might have the same faceted layer at the same depth, but with an ECTN 25. This improves our score to six, which is better but still not great.

Finally, in a third pit we do not find the facets, but there is a non-persistent weakness 130 cm down where we get an ECTN 23. Our score for this pit is a seven, which is a slight improvement. Thus, in general terms, the higher a pit scores, the better things seem to look. However, we wanted to more rigorously test the effectiveness of our scoring system.

Testing the Grom Score

To assess whether or not our scoring system differentiated between stable and unstable profiles, we used the SnowPilot database (Chabot et al., 2004; Snowpilot.org). We only included pits where an ECT score was reported and the user gave the slope a stability rating.

First, we manually scored 100 snow pits randomly drawn from the database without prejudice to date or international location. Since these initial results were encouraging, we automated the scoring procedure, applied it to over 3,000 pits in the SnowPilot database, and graphed our results.

RESULTS AND DISCUSSION

Our analysis of 3,393 pits in the SnowPilot dataset showed promising relationships between user's stability assessments and numerical scores from our proposed method (Fig 3). With each increase in the Grom Score from three to nine, the proportion of pits that users rated as "good" increased, while the proportion of pits rated as "poor" declined. This also holds generally for pits scoring a one or two, but the number of pits in those categories were small, so those results should be interpreted cautiously.

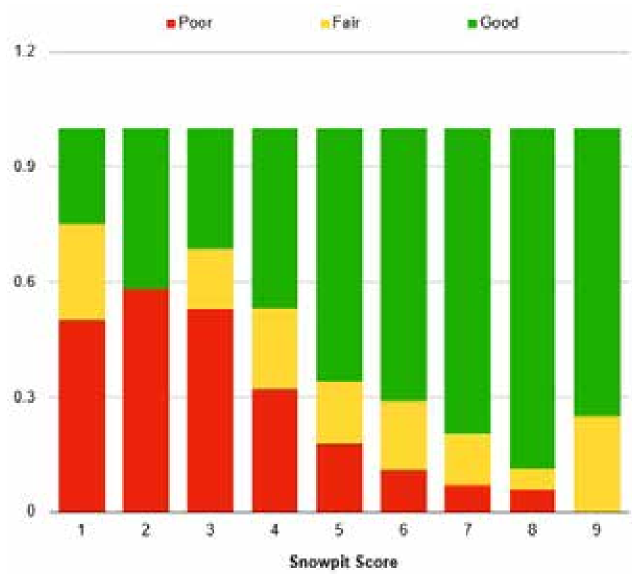

FIG. 3: THE PROPORTION OF STABILITY RATINGS ASSOCIATED WITH EACH PIT SCORE. THE NUMBER OF PITS WITH SCORES OF ONE, TWO, OR NINE ARE SMALL, SO THOSE RESULTS SHOULD BE INTERPRETED CAUTIOUSLY. NOTE THAT LOWER SCORES ARE MORE COMMONLY ASSOCIATED WITH POOR STABILITY AND HIGHER SCORES ARE MORE LIKELY TO BE ASSOCIATED WITH GOOD STABILITY. TOTAL N=3,393.

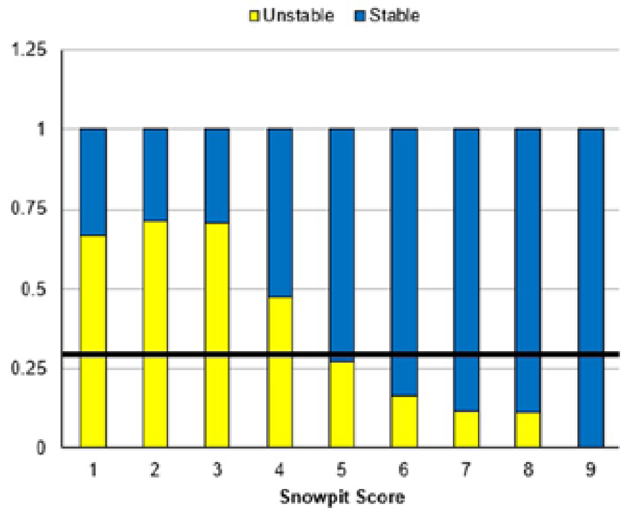

FIG. 4: FOR THIS GRAPH WE CLASSIFIED 6,670 PITS IN THE SNOWPILOT DATABASE INTO "UNSTABLE" AND "STABLE" BINS BASED ON THE CRITERIA USED BY TECHEL ET AL. (2020). FROM THIS WE CALCULATED 33% OF THOSE PITS WERE UNSTABLE, FORMING OUR BASE RATE (SHOWN BY THE BLACK LINE). HERE, WE SEE THAT AT LOWER SCORES, THE NUMBER OF UNSTABLE PITS EXCEEDED OUR BASE RATE, WHILE WITH HIGHER SCORES, THE NUMBER OF UNSTABLE PITS WAS LESS THAN OUR BASE RATE.

A critically important takeaway from our results is the variability in stability assessments associated with each pit score. For example, even though most of the pits with a score of three are rated "poor," about 30% of them are rated "good." At the other end of the scale, although about 90% of the pits scoring an eight are rated "good," that still means about 10% of the pits are associated with stability ratings of "poor" or "fair."

We also noted our scoring system is relatively conservative, with more of a tendency to give a stable pit a low score (i.e., 30% of the pits with a score of three are rated "good") than to give an unstable pit a high score (i.e., only about 5% of the pits with a score of 8 are rated "poor" and no pits with a score of 9 are rated "poor") (Fig. 3). This is a desirable characteristic since it encourages conservative decision-making.

In a further analysis, 6,670 snowpits were sorted into categories of stable (N=4,472) and unstable (N=2,198) based on the parameters of Techel et. al (2020). This gave a 'base unstable rate' of .33 (Fig. 4). The Grom Score for snow pits aligned well with the Techel stability observations. At scores of four or less, the number of pits rated unstable exceeded our base rate; at scores of six or more, the unstable pits were less than the base rate; and at a score of five, the number of pits rated unstable was roughly equal to our base rate. This gives us additional confidence that pits with lower scores are more likely to be associated with truly unstable snow, while pits with higher scores are more likely to be associated with stable snowpacks.

Some of the variability in our results may be explainable. We noted a few cases where pits with low scores that users rated as having "good" stability had unstable stability test results but relatively shallowly buried weak layers. However, other variations may be more challenging to explain. Ultimately, any pit scoring system—including ours—oversimplifies the more nuanced data contained in a complete snow profile. Thus, we strongly discourage using our pit scores to replace the important work of closely examining all the information contained in a profile. Instead, our method supplements the detailed information in snow pits by allowing avalanche professionals to quickly communicate general information to other professionals or the public.

CONCLUSIONS

The main goal of this work was to develop a method to quickly communicate snow pit information. The Grom Score can be easily communicated within an organization, to other avalanche professionals, and to the lay backcountry skier. While the Grom Score does not take the place of all the nuanced data contained in a snow pit, it does provide a quick and simple snapshot of stability based on snow pit information.

These scores can help untrained recreational users better understand pit results. Professionals can glean a great deal of useful information from a snow pit graph (see Fig. 5), but these plots may confuse untrained backcountry skiers. Using the Grom Score, we can communicate that this real-world pit scores a three and has poor stability. This pit scored zero for structure based on the presence of a PWL, depth, and a hardness change. It scored one for propagation with an ECTP, and two for strength with a tap of 14. The slope avalanched later in the week this observation was made.

Because the scoring method improves communication clarity, it may facilitate group decision-making. When we rate stability from very poor to very good, the words can be misconstrued and misunderstood. However, a numerical score is more easily understood and communicated. During the 2022-23 winter, the Grom Score was successfully used as

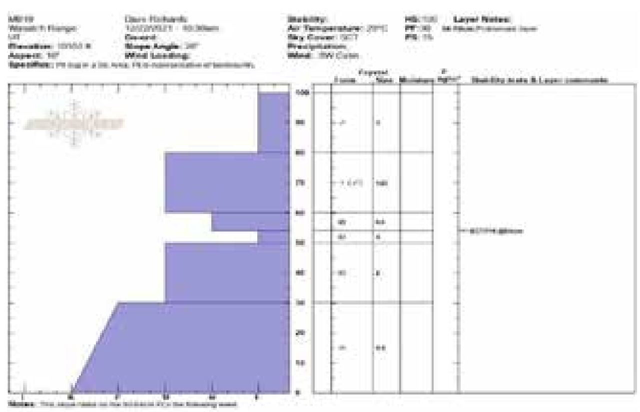

FIG. 5: A SNOWPIT WITH A GROM SCORE OF THREE. THIS SLOPE AVALANCHED LATER IN THE WEEK.

a decision-making tool by numerous educators from both the University of Utah and the American Avalanche Institute.

One especially useful way to use pit scores is to map them on an aspect/elevation diagram (Fig. 6). These graphs allow professionals and the public to condense all of the information contained in many snow pits into a simple, digestible diagram identifying current stability patterns. Using several of these diagrams over the course of a season provides a visual representation of changes in stability patterns. Avalanche educators and some heli-ski operations found this approach worked well during the 2022-23 winter.

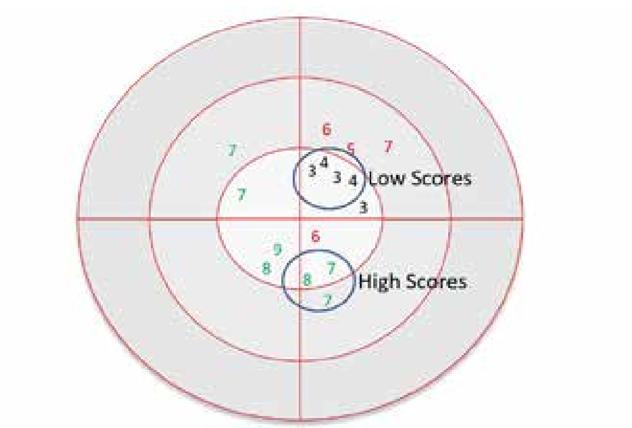

FIG. 6: EXAMPLE ASPECT/ELEVATION DIAGRAM WITH PIT SCORES. SUCH GRAPHS MAY HELP USERS TO BETTER DISCERN PATTERNS OF UNSTABLE SNOWPACK IN THE BACKCOUNTRY OR WITHIN AN OPERATION.

Summary

Avalanche professionals have discussed scoring snowpits for many years. Our method is a simple first step and a way to start the conversation with other professionals and researchers. That said, the initial feedback from a number of avalanche professionals is this first step is a worthwhile effort toward improving the standardization and communication of pit results.

Analysis of a large database of thousands of snowpits dug worldwide show the Grom Score correlates reasonably well with the stability assessments of avalanche practitioners. Anecdotal evidence leads us to believe that a numerical score may be a better method of communication than our typical stability ratings.

For this study we only used ECT results; however, some users do not apply this test. Perhaps a future iteration of our pit scoring method could utilize other stability tests such as propagation saw tests.

Avalanche professionals work in an environment of increasingly complex data, with even more complicated language to explain those data. We can simplify things by providing a snapshot of instability through our scoring method. Avalanche educator and helicopter ski guide Jim Conway summed things up when he told us: “The pit scoring system is simple to digest and use, and more importantly, it allows quick concise communications in the field environment. The system still allows for more detailed traditional pit evaluation data to be shared when this is needed.”

ACKNOWLEDGMENTS

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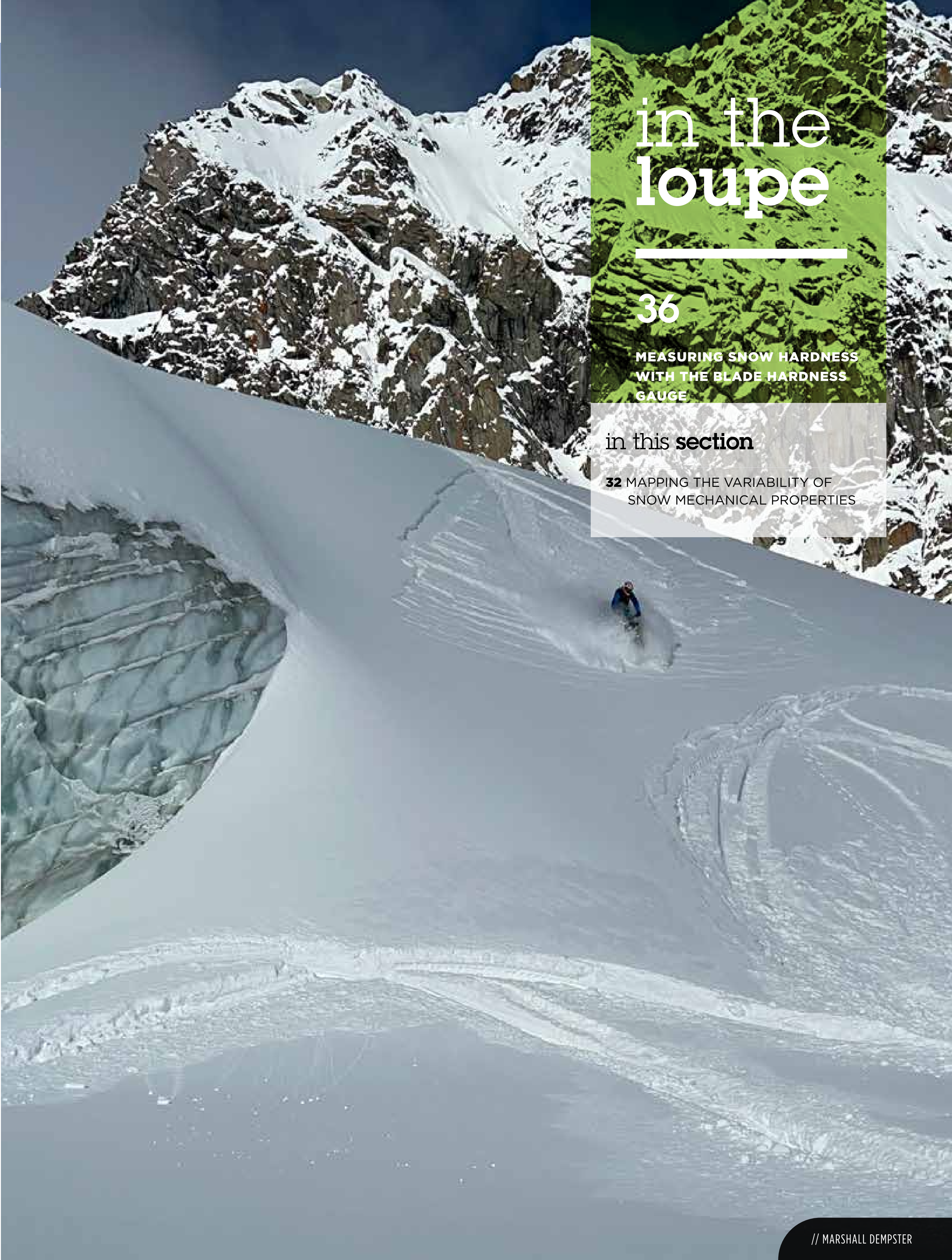
in the loupe

36

MEASURING SNOW HARDNESS WITH THE BLADE HARDNESS GAUGE

in this **section**



// MARSHALL DEMPSTER

Mapping the Variability of Snow Mechanical Properties at the Slope Scale

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INTRODUCTION

The spatial variability of snow properties is well documented in avalanche research (e.g., Schweizer et al., 2008). Studies have investigated the variability of stability tests on a slope (Kronholm and Schweizer, 2003; Birkeland, 2001; Campbell and Jamieson, 2007); and used statistical methods to map point-snow stability (Birkeland, 2001; Mullen and Birkeland, 2008; Reuter et al., 2015, 2016; Schweizer and Kronholm, 2007). These studies have shown point-snow stability can be partially mapped on the regional scale using topography such as aspect, altitude, and slope angle. This mapping can represent complex interactions between the weather and terrain, such as the effects of wind deposition and solar radiation (Reuter et al., 2016).

What about mapping stability for individual slopes? On this smaller scale, we can use microtopography to provide an even finer description of a slope. Indicators of microtopography include slope shape, vegetation cover, and wind and sun exposure, and can lead to more accurate estimates of the weak spots on a slope. They can aid professionals with potential avalanche size mapping (Veitinger et al., 2016) by using the variation of the snow mechanical properties as an input in snow mechanical modeling.

To test the relationship between microtopography and slope stability, we created a study whose main objective was to use microtopography indicators to create a map of snow mechanical properties that could help practitioners and recreationists choose safe routes through the backcountry, and determine proper locations for snow stability tests.

DATA AND METHODS

Study site and data collection

This study was conducted on Mount Fidelity in Glacier National Park, B.C., during the winter of 2021-22. We used a location named Jim Bay Corner, which is located below treeline at an elevation of 1,830 m. Our study plot was located in an open forested area with small shrubs, relatively low soil roughness, and 10 m tall trees that created some shaded areas. The slope angle was relatively constant (~20°), with small convex rolls around 5-10 m (Fig. 1). This article presents data collected on Jan. 19, 2022, from one of the snow spatial surveys collected that winter at Jim Bay Corner. Other studies were conducted on Mont Albert in Quebec, and on Round Hill, which is just above treeline on Mount Fidelity. The complete methodology is described in Meloche et al. (2023).

We measured the snow mechanical properties of the site for the stability assessment with the SnowMicroPen. The sampling was carried out by randomly traversing the site as shown in Figure 1. Next, two snow profiles were made at least 20 m apart, next to SnowMicroPen measurements. In each profile, we first performed two compression tests to identify the weak layers, then we visually characterized the types and sizes of the snow grains of the weak layer. Finally, we performed a propagation saw test to measure the critical crack length of the weak layer. This assessment enabled us to identify the weak layer in the nearest SnowMicroPen profile and then connect that to the remaining profiles.

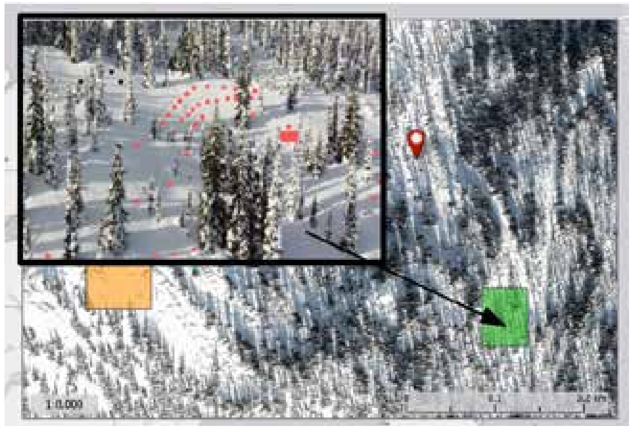

FIG. 1. MAP OF THE MOUNT FIDELITY STUDY AREA, WITH JIM BAY CORNER AND THE JAN. 19, 2022, STUDY HIGHLIGHTED. THE AERIAL PHOTOGRAPHY IS FROM THE UAV FLIGHT OF THE STUDY SITE AND THE SNOW SPATIAL SAMPLING IS REPRESENTED BY CIRCLES FOR THE LOCATIONS OF THE SNOWMICROPEN MEASUREMENTS AND THE SQUARES ARE THE SNOW PROFILE LOCATIONS. MAP CREDIT: ANTOINE ROLLAND.

All snow measurements were georeferenced using a GNSS receiver with centimetre accuracy. Additionally, 3D ground/canopy/snow surface models were generated using drone imagery. The following snow mechanical properties were mapped: slab thickness, slab density, and weak layer shear strength.

The skier propagation index (SPI) proposed by Gaume and Reuter (2017) was used to describe snow stability. SPI is defined by dividing the skier crack length (lsk) by the critical crack length (ac). A stable snowpack with a skier standing on top will have an SPI above 1, and an unstable snowpack has an SPI below 1. The skier crack length is the length of the crack in the weak layer that is induced by the weight of a skier standing on top of a slab, and was obtained from the SnowMicroPen-derived snow properties. We can assume the skier crack length gives relatively the same information as a compression test result. The critical crack length—the length of the crack required to begin a dynamic crack propagation—was obtained from the SnowMicroPen-derived snow properties and can be compared to the critical crack length from the PST. See Meloche et. al (2023) for details on how both lengths were calculated. It is important to note our goal was not to predict the stability metrics with high accuracy, but instead to model the spatial variation of these metrics.

Microtopographic indicators

Microtopographic indicators were generated from a 3D digital terrain and surface model. A canopy model showing tree

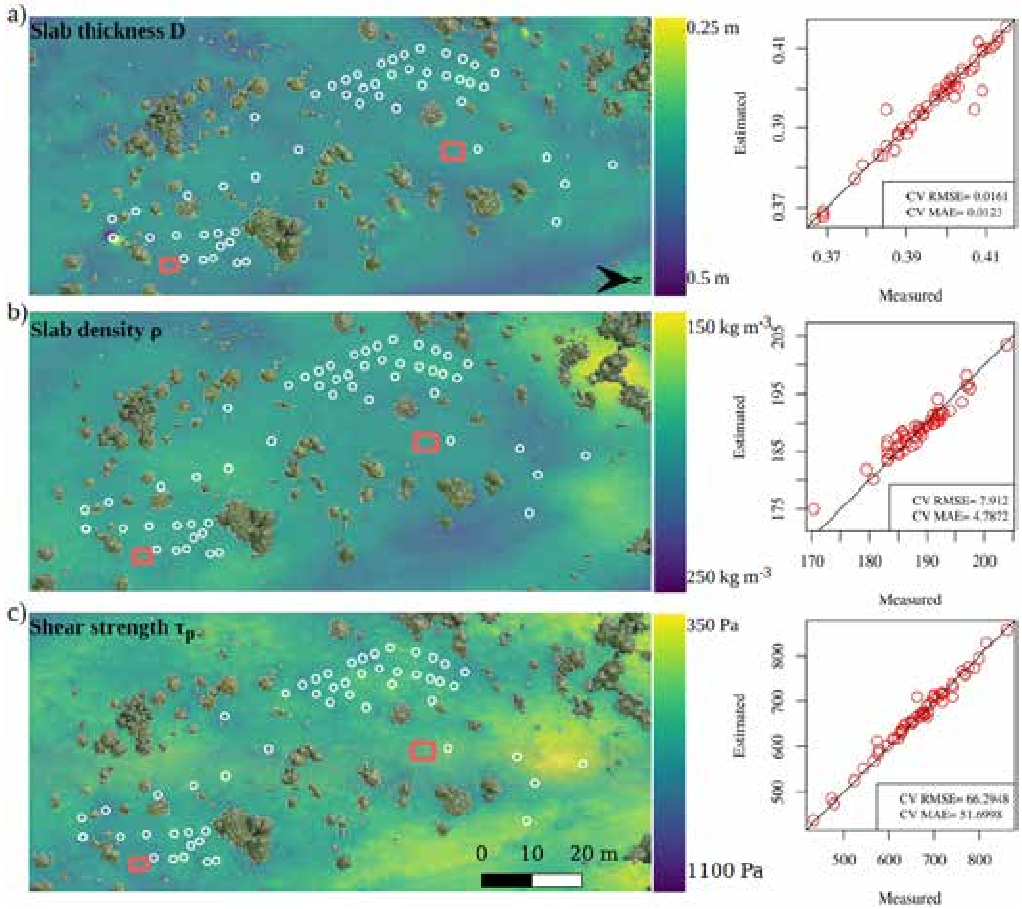

FIG. 2. SPATIAL ESTIMATION FOR THE SNOW MECHANICAL PROPERTIES OF A) SLAB THICKNESS D, B) SLAB DENSITY, AND C) SHEAR STRENGTH AT THE JIM BAY CORNER ON JANUARY 19, 2022 (SURFACE HOAR LAYER - 1MM). THE CROSS-VALIDATED ROOT MEAN SQUARED ERROR (RMSE) AND THE MEAN ABSOLUTE ERROR (MAE) ARE SHOWN NEXT TO THE MAP OF EACH PROPERTY. CIRCLES REPRESENT THE SMP MEASUREMENTS, AND SQUARES REPRESENT THE SNOW PROFILES. SNOW PROFILE 1 ON THE SOUTH SIDE AND SNOW PROFILE 2 ON THE NORTH SIDE.

height was generated by differentiating the surface from the terrain model. Snow depth maps were generated using a snow surface model that was compared to the terrain model to obtain the snow depth for each spatial snow survey.

Three groups of microtopographic indicators were measured: terrain shape, vegetation, and microclimate. We used two indicators to describe the shape of the terrain: the topographic position index (TPI), which is an indicator of the concavity and convexity of the terrain; and the vector ruggedness measure (VRM), which is an indicator of the roughness of the terrain below the snow surface. These two indicators are widely used in the literature to explain and estimate snow depth (e.g., Revuelto et al., 2020; Meloche et al., 2022; Veitinger et al., 2014). We also measured the slope angle at a small scale of around 1 m resolution. Since vegetation has an impact on the spatial variation of snow depth (Deems et al., 2006), our statistical model used the canopy height (presence of shrubs or small trees) and the radial distance from trees greater than 2 m as indicators. Solar radiation and wind exposure were also measured due to their impact on snow properties (Lutz and Birkeland, 2011, and Winstral et al., 2002).

RESULTS

The survey in this study was carried out when a persistent weak layer of surface hoar was buried in the snowpack. It consisted of 53 SnowMicroPen measurements over the span of 102 m. The overlying slab was composed of multiple layers and had a mean slab thickness of 0.39 m and a mean density of 188 kg/m3. The stability was moderate to hard, based on our compression tests, and the weak layer was not propagating, based on our PST (Table 1).

Our statistical model selected the most significant microtopography indicators to map the snow properties and stability metrics. The snow property maps were mostly accurate, with the slab thickness correctly predicted within a 1 cm error, the slab density within 7 kg/m3, and the shear strength within 67 Pa (Fig. 2). However, the stability predictions were less reliable, with an error of 40 cm for the skier crack length, 30 cm for the critical crack length, and 2.5 (no unit) for the SPI (Fig. 3). The map for slab thickness and density exhibited the same variation, with the same maximum and minimum areas. The map for the shear strength of the weak layer differed slightly from the map of the slab properties (Fig. 2). The areas of maximum and minimum values of weak layer strength were not necessarily in the same areas as the slab properties, but the main areas of maximum and minimum values were relatively the same. These results showed the spatial pattern of the weak layer differed from the spatial patterns of the slab properties in our dataset.

Microtopography

Our results show there are no specific microtopographic indicators that can be used to broadly map snow mechanical properties or stability metrics; however, TPI (the indicator of slope shape) and VRM (the indicator of terrain roughness) had a stronger relationship than others. Combining multiple microtopographic indicators was good for mapping snow properties and stability specifically on the site and the survey presented in this article. Results from the other sites are presented in Meloche et al. (2023).

Unfortunately, our results do not lead to general rules relating different types of terrain and microtopography to snow properties and stability for all slopes. However, they do demonstrate their usefulness for mapping snow properties and stability metrics on specific slopes, though without precision. TPI and VRM are shown to result in the best estimates of snow mechanical properties, especially the shear strength of the weak layer. This is in agreement with previous studies that used spatial models to estimate snow depth (Meloche et al., 2022; Revuelto et al., 2020).

TPI could be a good spatial estimator of stability in the field for backcountry recreationists, which is in line with common knowledge that steeper convex rolls are more unstable. VRM could also be a good estimator of stability, but it is more difficult to measure on snow-covered terrain.

The spatial variability of weak layers remains the main information to monitor regarding snow instability, but it is difficult to assess quickly in the field for backcountry recreationists. Creating more certainty regarding route finding is a challenge, but using microtopographic indicators in route selection at a slope scale could help us find safer travel routes—something practitioners have learned from years of experience travelling in avalanche terrain.

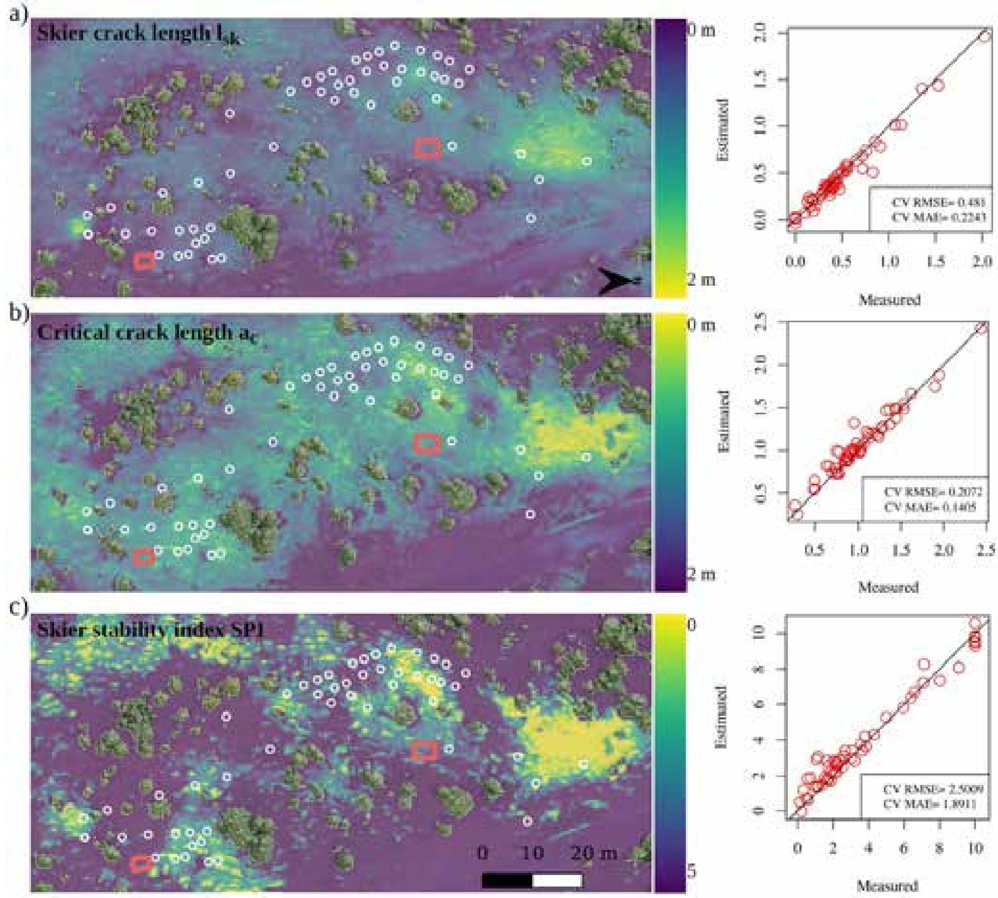

FIG. 3. SPATIAL ESTIMATION FOR THE STABILITY METRICS A) SKIER CRACK LENGTH LSK, B) CRITICAL CRACK LENGTH AC, AND C) SKIER PROPAGATION INDEX SPI AT THE JIM BAY CORNER ON 2022-01-19 (SURFACE HOAR LAYER - 1MM). CROSS-VALIDATED ROOT MEAN SQUARED ERROR RMSE AND MEAN ABSOLUTE ERROR MAE ARE SHOWN NEXT TO THE MAP OF EACH METRIC. CIRCLES REPRESENT THE SMP MEASUREMENTS, AND SQUARES REPRESENT THE SNOW PROFILES. SNOW PROFILE 1 ON THE SOUTH SIDE AND SNOW PROFILE 2 ON THE NORTH SIDE.

Stability tests

The goal of stability tests is to gain information on the stability of a given slope. This section looks at the locations of the two stability tests performed in this study, and how well they represent the whole slope. The generated map shows the range of stability values across the entire slope, which we can compare to the stability results from our snow profiles. The snow profile locations (see Fig. 3) were chosen to be representative of the slope as if we wanted to ski it. Figure 4 shows the distribution of the values of the skier crack length (l_{sk}), which expresses all the values of skier-induced stress; and the distribution of all the values of the critical crack length (a_c), which represent the propensity of crack propagation. A dotted line indicates the values of lsk and ac obtained for the location of the two snow profiles.

We can see our stability test results roughly approximate the mean slope stability from our SnowMicroPen survey. If the goal is to assess the stability of the slope, then aiming for the mean could be good; however, it does not represent the worst-case scenario described by the minimum value (the tails of the distribution). Knowing the minimum value could give us information on the potential trigger points. At this particular site, the results of the snow stability tests give us no information on the weaker area on the north side of the study site, which could be a potential trigger point (Figures 2 and 3).

This section presents no clear takeaways as to where our stability tests should be made, but rather puts into perspective our two snow profile locations compared to all possible values for a given slope. There is no obvious way to address the uncertainty created by the spatial variation of the snow mechanical properties. We hope this article provides a reflection to avalanche practitioners, based on a unique dataset, on where to do their snow stability tests to get a representative result.

CONCLUSION

We used microtopography to map the spatial variability of snow mechanical properties and some stability metrics. The maps created were reliable for the former but not the latter. We also looked at the utility of using microtopography to estimate snow spatial variability, but no general rules linking the two were found. Instead, the link between microtopography and snow instability seems to be specific to each site and snow properties. Slope shape (TPI) and soil roughness (VRM) were found to be the most useful microtopographic indicators for mapping snow mechanical properties and stability metrics; they should be explored in future work to estimate spatial patterns of snow mechanical properties as input for snow mechanical models. This could lead to the development of predictive methods in operational avalanche forecasting services to estimate the size of avalanche release using snow cover modeling and mechanical models.

For recreationists, while the map generated in this research represents unique teaching materials for avalanche awareness courses, additional work is needed on stability occurrence with respect to microtopographic indicators to help backcountry recreationists find safer travel routes. Future work could focus on differences in spatial variability between persistent and non-persistent weak layers.

We thank Jeff Goodrich and the avalanche control crew from Glacier National Park for their help and logistic support at Mt. Fidelity.

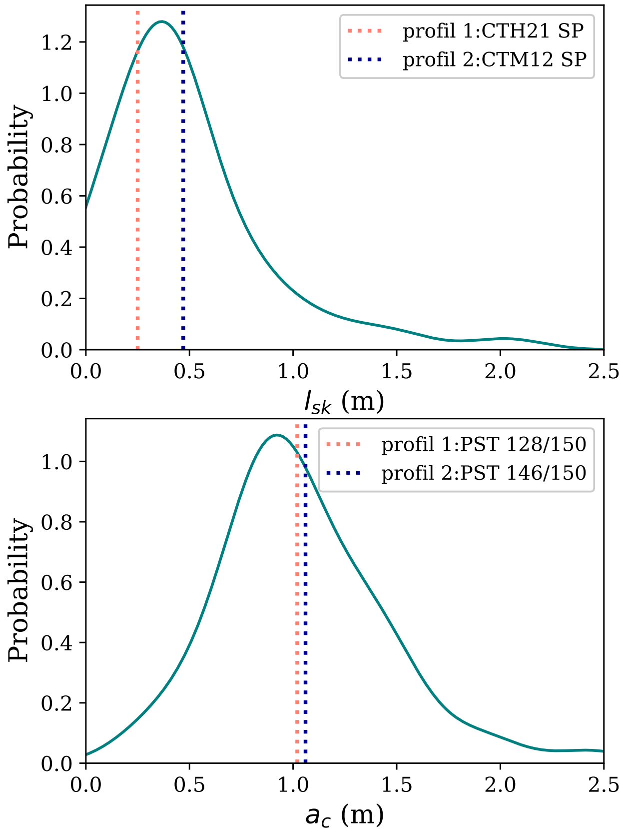

FIGURE 4. PROBABILITY DENSITY FUNCTION REPRESENTING THE DISTRIBUTION OF THE L_{SK} AND THE A_C VALUES AT JIM BAY CORNER ON JANUARY 19, 2022. THE DOTTED LINES REPRESENT THE VALUES DERIVED FROM THE MAP AT THE LOCATION OF SNOW PROFILES 1 AND 2. A LONGER L_{SK} IS UNSTABLE AND A SHORTER A_C IS UNSTABLE.

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Snow Hardness Measuring and Analysis Techniques With the Blade Hardness Gauge

Peter Barsevskis

INTRODUCTION

A predictive measurement used in avalanche forecasting is snow hardness, which is a measure of the snow's resistance to penetration by an object (Fierz et al., 2009). The resistance is due to the combination of snow grain bonds and structures, bending, rupturing, and compacting; along with the friction between the snow and the penetrating object (Borstad & McClung, 2011).

The first mechanical measurements of snow hardness were taken in 1936 using the Swiss rammsonde, a metal probe driven into the snow by the observer dropping specified weights on the probe (Haefeli, 1954; Höller & Fromm, 2010). Although capable of measuring snow hardness, it was unable to detect thin weak layers associated with slab avalanches (Schneebeli & Johnson, 1998).

The current standard for measuring snow hardness in Canada is the hand hardness test, introduced by Marcel de Quervain in 1950 (Canadian Avalanche Association, 2016). The test has the operator exert 10-15 N of force using physical objects of decreasing surface area (fist, 4 fingers, 1 finger, pencil, and knife) into the snowpack. This standard has been set by "The International Classification for Seasonal Snow on the Ground" (Fierz et al., 2009). Furthermore, the CAA has operators add + and - indicators to illustrate variations in hardness (Canadian Avalanche Association, 2016). However, this test has shortcomings in accuracy due to bias amongst users, failure to consistently apply 10-15 N, misusing ± classifications, and varying hand sizes (Pogue et al., 2018).

A promising technology to address these shortcomings is the blade hardness gauge (BHG). This work investigates the reliability and integrity of the BHG with respect to measuring snow hardness.

The BHGs used in this study were the third and latest model produced by Fraser Instruments Ltd. (Fig. 1). The blade is stainless steel, 0.6 mm thick, 10 cm wide, has a force range of 0–50 N and is precise to 0.05 N. It measures and displays the peak resistance hardness as the blade is inserted into the snowpack.

The BHG is based off the thin-blade tool introduced by Borstad and McClung (Borstad & McClung, 2011). The thin-blade device allows the avalanche practitioner to measure the hardness of thin weak layers over time (Pogue & McClung, 2016). A Parks Canada study comparing the BHG and the hand hardness test concluded the ± indexes had no meaning, that fist and four-fingers hardness was basically the same, and that further testing was needed for operator bias (Pogue et al., 2018).

OBJECTIVES

This research had the following objectives:

- Determine if there is a difference in recorded BHG measurements between fast (≈ 10 cm/s) and slow (≈ 1–3 cm/s) insertion rates into the snowpack.
- Determine if there is a difference in recorded BHG measurements depending on the orientation of the BHG into the snowpack.
- Find a correlation between BHG measurements and the hand hardness test.
- Test the replication of the hand hardness test versus the BHG amongst avalanche technicians.

METHODS

This study occurred over the 2020–21 and 2021–22 winters. The primary field sites were within the Kicking Horse Mountain Resort tenure and the surrounding backcountry in Golden, B.C. Additional field data was gathered in the Canadian Rockies, Rogers Pass, Big White Ski Area, and Whistler Blackcomb. The snow profiles carried out in the designated study sites adhered to the observation and recording guidelines set forth by the CAA (Canadian Avalanche Association, 2016). Further observations were made using the BHG.

Insertion rate

The BHG was inserted into the snowpack at both fast and slow rates, at the same depth and at the same angle (slope parallel). The insertions were spaced roughly 2 cm apart.

To determine the consistency of fast versus slow measurements, a second experiment was completed where layers of homogenous snow greater than 10 cm in height were used to complete 10 fast and 10 slow measurements. The BHG was inserted perpendicular to the slope angle to reduce spatial variability of the snowpack in relation to snow layering. This procedure was carried out in multiple layers of snow differing in snow hardness.

In both experiments, the velocity of insertion rates was standardized through timer and ruler-based measurements, where velocity was the measure of the distance covered in a given amount of time. These calibrations were conducted inside by the researcher before venturing into the field. During fieldwork, the researcher subjectively assessed the insertion rates.

Orientation

The natural snowpack is made up of different stratigraphic layers as the snowpack transforms throughout the winter season. Due to elevation, terrain, weather, and snow metamorphism, there is a range of snow hardness throughout the snowpack. This research explored the orientation of the BHG with insertions parallel and perpendicular to the snowpack to measure the snow hardness.

Homogenous snowpack layers with a height of 10 cm or more (determined through a combination of visual and physical methods in excavated snow profiles) were used to compare six horizontal BHG measurements (blade parallel to the slope) and one vertical BHG measurement (blade perpendicular to the slope). For the horizontal measurements, intervals of 2 cm were employed vertically, resulting in a cumulative vertical height of 10 cm. The vertical measurement was obtained over the entire 10 cm distance. Both horizontal and vertical measurements were spaced roughly 2 cm apart and their corresponding values were documented.

Hand hardness

Blade hardness measurements were conducted in conjunction with the respective hand hardness profiles, with the aim to quantitatively gauge the hand hardness scale. An avalanche technician recorded hand hardness for each layer, while the researcher performed BHG measurements at approximately 2 cm intervals within the layers to ensure uniform measurements. The insertion rate for all BHG measurements was maintained at approximately 10 cm/s, with the researcher subjectively assessing the rate.

To assess the repeatability of both the hand hardness test and the BHG, avalanche technicians sequentially executed hand hardness and BHG measurements. Each technician was unaware of the measurements taken by the others to ensure independence. The technicians were instructed to carry out BHG measurements with a consistent, rapid insertion rate of approximately 10 cm/s, every 2 cm within the layers. These sets of measurements were obtained from the same snow profile, with minimal time gaps between technicians to mitigate weather-related influences, and minimal spacing to mitigate spatial variability effects in the snowpack.

RESULTS

Insertion rate

Pairs of BHG measurements were taken to test if there was a difference in BHG measurements with respect to fast and slow insertion rates. A total of 136 in situ pairs were taken in snow profiles consisting of dry snow ranging in blade hardness 0.1 N to 36.2 N (Table 1). The data supports there is statistically significant difference between the fast and slow rates (WS = 1938.00, $p < 0.01$).

To test the consistency of the insertion rates, trials of 10 fast and 10 slow measurements were taken in layers of homogenous snow greater than 10 cm in height. This procedure was carried out in multiple layers of snow differing in snow hardness, resulting in 11 trials for consistency. A fast insertion rate resulted in more consistent measurements than a slow rate (Fig. 2).

Insertion Rate	Average (N)	Standard Deviation (N)	Standard Error (N)
Fast	6.47	7.54	0.65
Slow	8.01	9.00	0.77
Difference	-1.54	2.69	0.23

TABLE 1. DESCRIPTIVE STATISTICS COMPARING FAST AND SLOW INSERTION RATES WITH THE BHG (DIFFERENCE = FAST – SLOW).

Orientation

186 vertical BHG measurements (height of 10 cm) were compared with 186 mean horizontal measurements in homogenous layers of dry snow greater than 10 cm in height (Table 2). The data supports there is a statistically significant difference between the two BHG orientations (WS = 6206.00, $p < 0.01$).

Orientation	Average (N)	Standard Deviation (N)	Standard Error (N)
Vertical	4.90	5.61	0.41
Mean Horizontal	5.19	6.01	0.44
Difference	-0.29	1.19	0.09

TABLE 2. DESCRIPTIVE STATISTICS COMPARING ORIENTATION OF THE BHG (DIFFERENCE = VERTICAL – MEAN HORIZONTAL).

Hand hardness

A total of 68 hand hardness profiles by 33 avalanche technicians were taken, along with corresponding BHG measurements. The technicians classified the hand hardness test with the five hand hardness indices (F, 4F, 1F, P and K) and the ± indices. A total of 4,229 BHG measurements were compared with the hand hardness indices (Fig. 3).

To see if there was a difference in the hand hardness indices based on experience, the data from the hand hardness profiles was split up based on the avalanche technician's certification. A total of 36 profiles were taken by 20 different avalanche technicians with Avalanche Operations Level 1, and 19 profiles were taken by 13 technicians with Avalanche Operations Level 2, along with corresponding BHG measurements (Fig. 4).

The log box plots seen in Figures 4 and 5 visualize the overlap in the data between the hand hardness values. Comparing blade hardness with hand hardness shows significant overlap between the neighbouring hand hardness levels. The log scale of the blade hardness forms an almost linear relationship with the hand hardness as the surface area of each hand hardness level decreases.

To test the reproducibility of the hand hardness test and the BHG, avalanche technicians took corresponding hand hardness and BHG measurements one after another. Throughout the research a total of 286 snow layers were compared with the hand hardness test and 208 snow layers were compared with the BHG. The results are shown in Figure 5.

Figure 5 indicates the percentage of layers in agreement between avalanche technicians was 90.4% when using the BHG, in contrast to 40.2% when employing the hand hardness test with the ± indices. This highlights the superiority of the BHG over the hand hardness test in measuring snow hardness amongst avalanche technicians. Excluding the ± notations, the consistency of the hand hardness test amongst avalanche technicians increased significantly to 67.8%.

DISCUSSION

The rate at which the BHG is inserted into the snowpack holds significance in achieving uniformity amongst users. This research investigated both fast (≈ 10 cm/s) and slow (≈ 1-3 cm/s) insertion rates. The analysis revealed a statistically significant disparity between the two rates, with slow insertion giving larger hardness values. Faster insertion rates tended to give lower variability and better consistency. By comparing these findings with existing literature (Bradley, 1966; Fukue, 1977) it is advisable to employ an insertion rate of approximately 10 cm/s into the snowpack to ensure

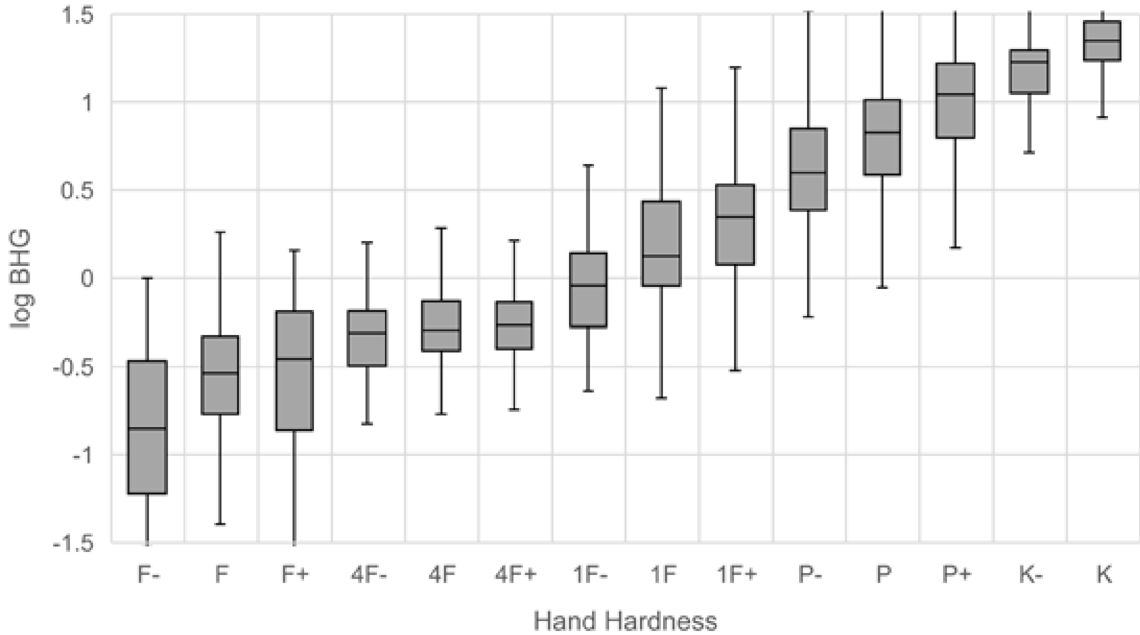

FIGURE 3: A LOG BOX PLOT COMPARING HAND HARDNESS INDICES WITH BHG MEASUREMENTS FROM 68 HAND HARDNESS PROFILES BY 33 AVALANCHE TECHNICIANS. THE GREY BOXES REPRESENT THE FIRST AND THIRD QUARTILES, AS A MEASURE OF SPREAD, THE VERTICAL LINES SHOW THE FULL SPREAD OF THE DATA, AND THE LINES IN THE BOXES REPRESENT THE MEDIAN VALUES.

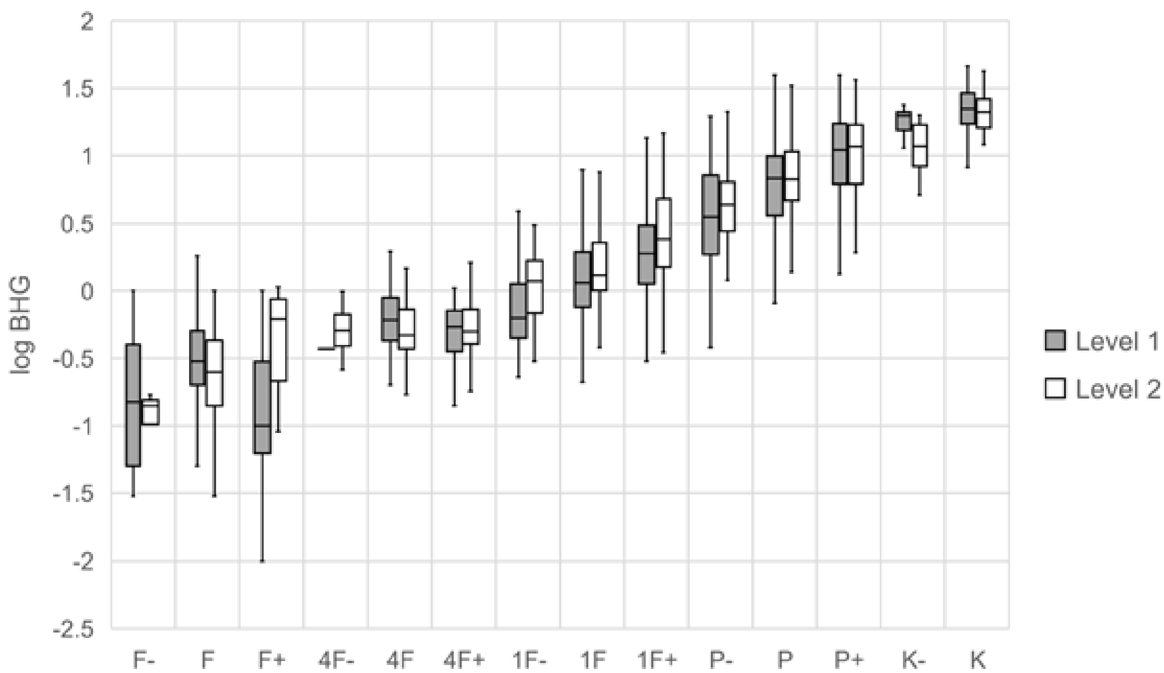

FIGURE 4: A LOG BOX PLOT COMPARING HAND HARDNESS INDICES WITH BHG MEASUREMENTS BY CAA LEVEL 1 AND LEVEL 2 OPERATORS.

consistency amongst users. Adequate training should be provided to BHG users to maintain a consistent and fast insertion rate.

With regards to orientation of the BHG, the data supports a statistical difference between one perpendicular measurement and the average of six parallel measurements. There is variation amongst the measurements, especially in non-homogenous snow layers. The recommendation is to insert the BHG parallel to the snowpack in two-centimetre increments, with extra measurements taken at the location of persistent weak layers to gain the most precise hardness profile.

As the hand hardness test is the current standard for measuring snow hardness in Canada, this research set out to further correlate the BHG with the hand hardness test. The data from the 68 hand hardness profiles with correlating blade hardness measurements, seen in Figure 4, resulted in no difference between the ± indices in the four fingers category. The data from the 19 hand hardness profiles from CAA

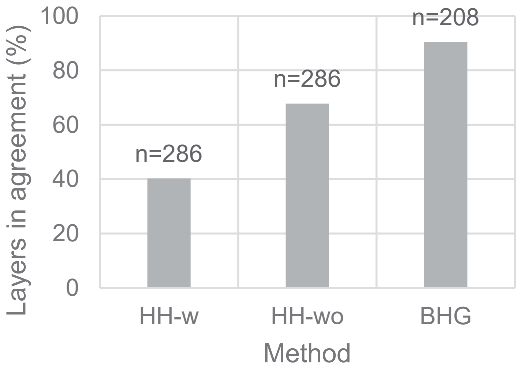

FIG. 5: SIDE-BY-SIDE SNOW HARDNESS REPLICATION OF THE HAND HARDNESS TEST WITH THREE INDICES (HH-W), THE HAND HARDNESS TEST WITHOUT THREE INDICES (HH-WO), AND THE BHG..

Level 2 operators, seen in Figure 5, resulted in no difference between F+, 4F-, 4F and 4F+ indices. This illustrates avalanche technicians have a hard time distinguishing hardness difference in soft snow and that the ± indices do not have meaning in soft snow. These results are similar to what Pogue et al. found (2018).

Hand Hardness Index	Blade Hardness (N)
Fist	0 - 0.4
Four Fingers	0.4 - 1
One Finger	1 - 4
Pencil	4 - 14
Knife	14 - 45

TABLE 3: HAND HARDNESS AND BLADE HARDNESS SCALE.

A comparison of hand hardness and BHG profiles amongst users showed BHG measurements were more consistent amongst users than the hand hardness test.

Data from this research was used to create a blade hardness to hand hardness scale as seen in Table 3. The BHG can be used as a teaching tool to introduce and improve consistency of the hand hardness test amongst users. It offers the users the ability to feel what 10-15 N of force feels like, which is the insertion force of the hand hardness test. By measuring the blade hardness, the user can identify the corresponding hand hardness by using the provided scale. Continuous calibration of the hand hardness test with the BHG could lead to greater consistency amongst avalanche technicians.

The outcomes of this research suggest the removal of the ± indices from the hand hardness test would enhance the reproducibility among avalanche technicians. However, within a single snow profile, a particular avalanche technician can utilize the ± indices to assess hardness discrepancies between snow layers in each snow profile. Those ± indices will overlap the other indices over time and will not necessarily be reproduced by another technician. For a more accurate and consistent assessment of snow layer hardness over time, it is recommended to measure the snow hardness with the BHG instead of the hand hardness test.

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snow globe

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IN MEMORIAM

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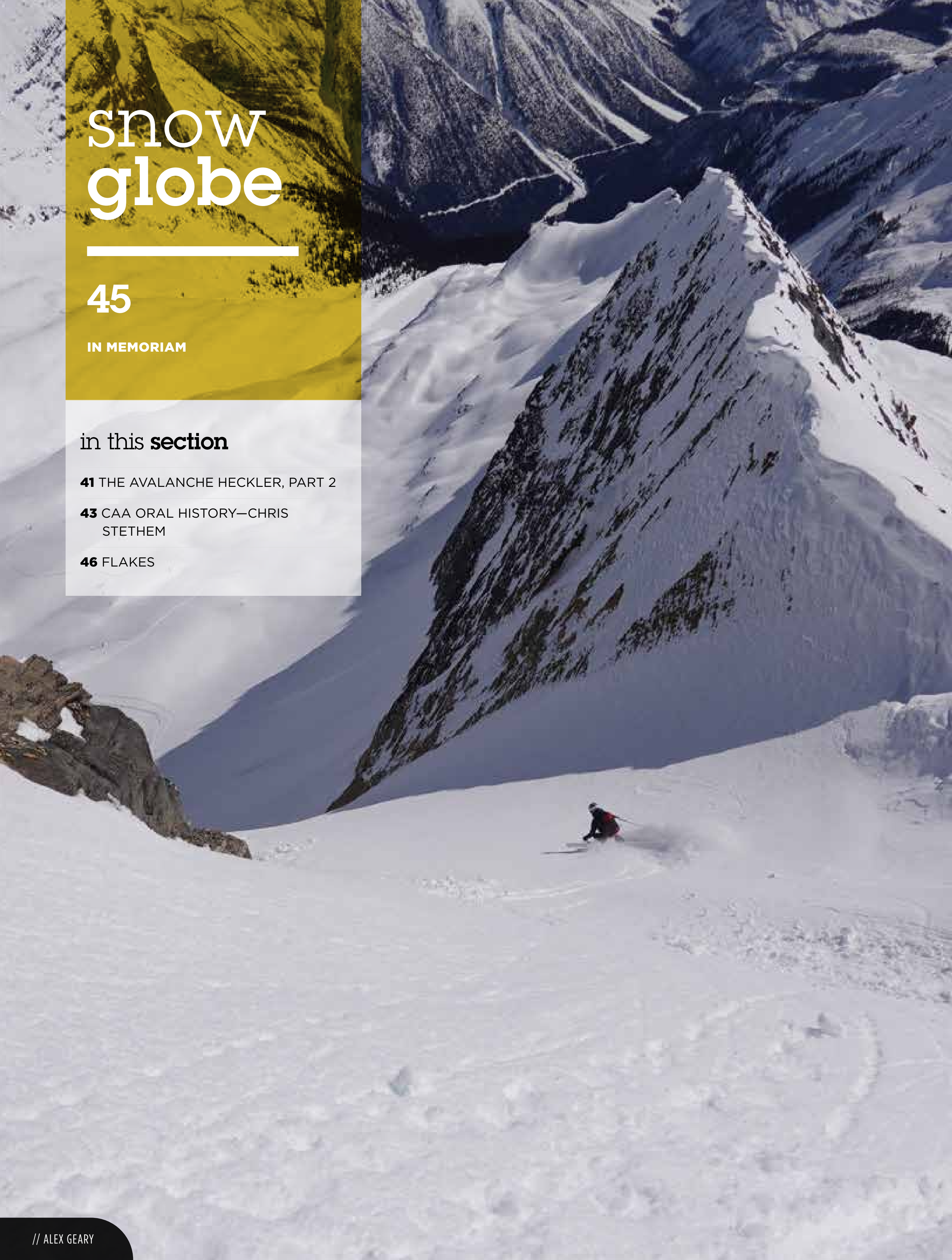


// ALEX GEARY

The Avalanche Heckler—Part 2

Brendan Martland

WELCOME TO ANOTHER instalment of the heckler series, where we continue to discuss riveting topics such as semantics in the avalanche patch. I hope everyone is **settling** into their chairs, **tightening up** their slippers and reminiscing their enjoyable day in the **slackcountry**. Here we go for round two of a list of terms that are being used incorrectly (in my sarcastic opinion) in the avalanche industry.

Let's get our heckles up!

Beacon: An intentionally conspicuous device designed to attract attention to a specific location. A common example is the lighthouse, which draws attention to a fixed point that can be used to navigate around obstacles or into port. More modern examples include a variety of radio beacons that can be read on radio direction finders in all weather, and radar transponders that appear on radar displays.

What's wrong with the term "beacon" you ask? Everyone uses that term. I learned it on my RAC course (sorry youngsters, inside joke). Oh yes, there are so many options for this one. How about:

[Well educated professional]: "Can you do a beacon check please, Martland?"

[Sarcastic unprofessional heckler]: "Sure thing. I'll start with the InReaches, Zoleos, and SPOT units, then the iBeacons, and there might be some ResQlinks in the crowd. Then the Recco detector, and those flashing lights on people's backpacks, and luckily the lighthouse is easy to see from here..."

In this day and age where new gadgets are flying off shelves and everything has a clever label to help make it sell, a "beacon" likely means something completely different to most people. Yes, as avalanche professionals we all know we're talking about *avalanche rescue* beacons, but are we helping to clarify the issue when we use that term? Are outsiders, newcomers, and untrained future superstars getting the head start they need to thrive in the realm of avalanche rescue if they don't even know what we're talking about? Think of all the sad teenagers who will wake up on Christmas morning, bursting with anticipation of the one gift they really want (and *need*), only to unwrap a magnetic flashing orange strobe light to stick on the roof of the Toyota Tacoma they got in their stocking.

Avalanche transceivers save way more buried people than beacons. Pass it on.

"Sc" Skier-controlled: An avalanche that is deliberately initiated in a controlled manner by a person on skis or snowboard, such as ski cutting a slope, cornice, etc...

Oh, we could have some fun with this one. First of all, Sc stands for skier-controlled, not ski cut. A ski cut done well is one method of initiating a skier-controlled avalanche. Many of us in our work practices deal with a lot of uncertainty, and decisions are made based on all the data available. This is fine, it's the nature of our job—we're not always going to get it exactly right. That means when we *assume* we will initiate an avalanche in a controlled manner on skis, but we *discover* that in fact we misjudged it for some reason and didn't quite execute it in a controlled manner, we can't call it "Sc" on any of our paperwork. When I'm knocked off my feet by an avalanche and go for a tumble, I am in no way in control of it—it's in control of me. I might even have to search for my favourite poles for 10 minutes if I'm really unlucky.

I have therefore entered the realm of the **Skier Accidental (Sa)**. Ooooooooohhhhh! Must have been an epic disaster! Not at all. This term accurately defines how the avalanche was triggered—not by a person in complete control, even though plans were made to do a ski cut and all safety protocols were followed. The avalanche was triggered *accidentally* at an inconvenient time, depth, or location for me. It has become an **Sa, occurring during ski cutting**.

[Well educated professional's InfoEx Submission]: "Sc size 1.5 windslab, technician went for short ride losing poles. Crown much higher on slope than expected."

[Unprofessional avalanche heckler]: "Epic disaster covered up by changing a vowel to a consonant—an A to a C nonetheless. Who does that?!?"

It is worth mentioning that this certainly includes **Ma/Mc** for sledders (Machine Accidental vs Machine Controlled) and **Va/Vc** for snowcat vehicle operators. It's not just the skiers and snowboarders getting surprised out there.

Accidental triggers are very common—let's all embrace this reality and call a spade a spade (or maybe I should say rescue shovel).

Density change: Density—a measured degree of compactness of a substance. Change—make or become different.

OK, now we're really getting technical. This one is more for style points than anything, but it has been mentioned quite a few times on courses and, technically speaking, we're not using the right term.

When we poke a finger in the snow at an interface and notice a difference in resistance, it's just that: a **resistance change**. As hard-charging snow scientists, we should know better than to make blind assumptions that this interface is in fact a change of density between two layers. The only way to know snow density is to measure it, so get out your scales and tubes if you want to keep using this term.

Fun fact: mature, well-spaced facets may be the exact same density as the stiff wind slab above them, even though the resistances are dramatically different.

[Well educated professional]: "There's a clean shear down 40cm at a density change."

[Unprofessional avalanche heckler]: "That's an interesting hypothesis, Dr. Snowflake, but keep in mind that to follow the scientific process you need concise, predictive, coherent, high-integrity data to support your assumptions. Maybe *you* need a density change."

Temperature crust: Temperature—a degree of hotness or coldness measured on a definite scale. Crust—a hard outer covering or surface layer.

As you roll your eyes and yawn, consider briefly that you did in fact agree to use the well researched and fully implemented *Observation Guidelines and Recording Standards for Weather, Snowpack and Avalanches*. In this great little field guide to avalanche nerdiness, there are all sorts of different snow crystals, grains, and crusts that are described at length. But nowhere in the entire document is there any mention of this mysterious *temperature crust* I keep hearing and reading about. Why is that? Is it because there's a better way to describe the process of metamorphism of the surface grains? Or did the Technical Committee and all those researchers just not think of it? Hard to say. It does sound valid that "a layer of grains that refreezes after having been wetted by melt or rainfall" has gone through a melt-freeze process, which would arguably make it a… **melt-freeze crust!**

[Well educated professional's InfoEx report]: "Cold dry snow above 2000 m, temperature crust below this elevation."

[Unprofessional avalanche heckler]: "Cold ones are on you buddy, I'm too crusty to care anymore."

As we strive for perfection in our complicated profession, it is important that we at least sound intelligent when we talk about heaps of snow sliding down mountainsides. One of the first steps in this process is to use the appropriate terms that will best serve the safety of the public, the development of our profession, and my overly critical reaction to all of this blasphemy. It's time we step it up, folks!

I'll sign off with a favourite quote from the OG Avalanche Hunter, Monty Atwater: "I feel privileged to have been fated to play my part… and I have loved every minute of it: the triumphs, the defeats, the frustrations, the half victories, the controversies, the Hearts games, the rescues that ended in tears and those that ended in the nearest bar."

And on that note, I'm off to the pub for some more research. Be safe, and more importantly, be correct :)

Do you have a response for Brendan, or want to do some heckling of your own? If so, please email acooper@avalancheassociation.ca.

Dear Heckler: **Loosen Up!**

Hi Brendan/Alex,

Before I begin heckling, I'd like to give praise to Part One of the Avalanche Heckler series. I enjoyed the language, humour (particularly the sarcasm), and learning provided by your article.

I am a ski patroller and avalanche educator. I do receive a copy of the CAA magazine when it goes to print so I think that makes me an industry professional. Although beneath all of that, I am mostly a "well-intentioned" ski bum.

Funnily enough, according to you, I have used all three of the words discussed incorrectly! I feel like an idiot now. I am not willing to debate Numbers 1 (settled) and 2 (slackcountry), because I think you're right. Number 3 (tightening up) however, someone might be wrong or maybe we're both right.

So, the opposite of tight is loose. And I know this because I have some loose mates. A couple of definitions of loose are: "not firmly held or fixed in place," and "free from anything that binds or restrains." This could describe an avalanche cycle in its prime.

To say that something is "tight" would be suggesting the opposite of these definitions. And to say that something is "tightening up" would be to move from a state of being loose to tight, or tighter than prior. I wouldn't think the English language would limit the description tightening to screwing a lid on a jar or tightening a propane tank. I hope not anyway, because I feel some of my friends have really tightened up over the last few years!

Looking forward to some more heckling in the coming series.

From a dedicated avalanche professional who lives close to the Rockies but not in them,

Joanna Waterston

CAA Oral History - **Chris Stethem**

Alex Cooper

FOR THE CAA'S 40TH ANNIVERSARY, we began interviewing key figures in the history of the association in order to capture our history. We are pleased to present excerpts from these interviews in *The Avalanche Journal*.

This is from my interview with Chris Stethem, a founding member of the CAA and Past-president. Chris began his career in the industry in 1972 with Whistler Ski Patrol and went on to start his own consulting firm, Chris Stethem & Associates, which was an industry leader for several decades. He was President of the association from 1988 to 1992, when the Canadian Avalanche Centre was first founded. Here, he talks about the founding of the CAA in 1981 and being elected President in 1988.

Note: This interview has been edited for length and clarity. The full transcript and audio of the recording are available at avalanchejournal.ca.

Alex Cooper: Were you involved with the Canadian Avalanche Committee[1] at all?

Chris Stethem: I went to a meeting or two, but no, that was a government thing. That was Ron Perla, Dave Pick, Geoff Freer, and Peter Schaerer—government people, representing Parks, NRC, BC Highways, and Environment Canada.

Ron Perla took me to one of those meetings, and he was a shit disturber a bit. He said, "We should really have other people involved." Just kind of an idea at the time, and I don't know when that was. I'll guess 1976, '75, somewhere in there. They had tried to get together an avalanche program, like a centre program, and that's what they were talking about for a long time.

They couldn't get it together because Geoff Freer lived in Victoria, where BC Highways' head office was and he was their servant. Peter Schaerer lived in Vancouver and that's where the National Research Council office was. Perla lived in Canmore and his field station was at Sunshine, and his masters were in Saskatchewan for Environment Canada. Then Dave Pick was in Calgary with Parks, so they couldn't… Revelstoke was the logical place. They all knew that in a sense. Peter was the only one who was willing to go there or who could go there.

CHRIS IN A HUT DURING HIS TRIP TO FRANCE ON THE HAUTE ROUTE. // CONTRIBUTED BY CHRIS STETHEM

The CAA was formed in 1981. Can you tell me what the discussions were like in the avalanche industry leading up to the formation of the CAA?

It started in the '70s for a variety of reasons. There had been accidents in the '70s where there had been recommendations from the coroner, twice I believe, to exchange information to have better communication, and that inspired the InfoEx. There was the Avalanche Committee. The schools really were what we congealed around, because those of us who were instructors in the schools were called to spring meetings by Peter (Schaerer) every year. Those meetings grew by osmosis as more people came along—people who were senior in the industry, were interested in instruction, but had full-time jobs. So, we all ended up meeting in the spring.

[1]The Canadian Avalanche Committee was formed in 1975 and consisted of Peter Schaerer (National Research Canada), Ronald Perla (Environment Canada), Geoff Freer (B.C. Ministry of Transportation and Highways), and Dave Pick (Parks Canada). (Montagne, J., and Schaerer, P., ISSW Part, Present, and Future, Proceedings from the International Snow Science Workshop, 1994.)

Then at some point in the late-70s, the meeting of avalanche instructors became the Avalanche Safety Operators meeting. All the people from avalanche safety operations were invited by Peter to come to meetings. I would say that might have started around '79. There was a meeting in Banff and somebody was kicking this idea around again—it might have been Brian Weightman from the Canadian Ski Patrol—that said you should become an association.

I don't know if anything serious was done about it, but in the next year it was formally proposed we should form an association at that safety operators meeting. We went around and got a small group together to be the original board, if you like. You needed a certain number of applicants to get an approval under the Societies Act, which is where we started.

In the summer of 1980, we put those applications together and my lawyer in Squamish put the papers together for the B.C. government. They approved it and we had our first formal meeting in the spring of '81. Peter became the first President. I can't remember who sat on the board then, but whatever number, there was Peter, Geoff Freer from highways, myself, Walter Schleiss, Herb Bleuer, and Willi Pfisterer.

What were the qualifications to be a member when you formed?

That's a very good question. I think, without looking at the writing, you had to be full-time in the avalanche profession in some way, shape, or form. That could have been rescue, avalanche control, research, whatever. And you had to have at least two years' experience in formal application of avalanche safety work, avalanche control, research, you name it. That was it, and people applied, so there it was. I have the original list, actually. I think there was about 40-odd people that signed up.

CHRIS STETHEM GREW UP IN ONTARIO AND IS CURRENTLY ENJOYING RETIREMENT IN CANMORE, ALBERTA. // CONTRIBUTED BY CHRIS STETHEM

When I was looking through old issues of *Avalanche News* to prepare for this, I found one where it said there was 70-odd members, this was in the late '80s when you were President. It started very small. Now there are over 1,000 members.

It could well be. When we made the application there were seven of us. That first meeting I'm pretty sure I have a list of names there, there were 40 or 41.

What were some of the first things as an association you felt you had to take on?

We had five goals, I think, in the original registration document. They included, not necessarily in this order: education, research, public information, resources, and professionalism.

Was standardization something you were focused on?

Yes, they were big in the '80s and even in the '70s. The first guidelines I think were written in 1979 and were published in 1980. They were an offshoot of the schools. They were an offshoot of the old Rogers Pass documents, largely around how you observe the weather and that sort of thing.

What were the big challenges you were facing when you were trying to get the CAA started up?

Well, the same challenges everybody faces in terms of money. How do you pay for what you do? I think recognition or legitimacy, or whatever you want to call it. You are seeking recognition, so trying to get your name out there to become recognized as the body representing (avalanche workers). That happened, but it took a few years, the first 10 years, to really get established until this thing was running.

So, you became CAA President in eighty ....

In '88. And I wasn't even there.

How did you get tapped for that role?

I don't know. Darro Stinson came up to me after the election and said, "So, we just elected you President—what do you think of that? Is that okay?"

So, you hadn't put your name forward, but you'd been on the board?

I was on the board from '81-84, and I left so they could get more diversity, get more people involved.

So, why did they choose you?

Just involvement over the years. I think at the time I was involved in the Education Committee or schools, and we were in the process of taking (training programs) over and so that all followed.

To read or listen to our complete interview with Chris Stethem, visit avalanchejournal.ca.

Remembering **Wayne Flann**

THE CANADIAN AVALANCHE community lost a key figure when Wayne Flann died on Sept. 21, 2023. Wayne was a patroller and forecaster at Whistler Blackcomb for almost 40 years, a CAA Avalanche Professional, a trauma paramedic, and a member of Whistler Search & Rescue for over three decades. He was best known for the Wayne Flann Avalanche Blog, where he posted daily avalanche information focused on the Sea-to-Sky area for 12 years. He was the recipient of the CAA Service Award in 2020 for all his contributions to our industry and public avalanche safety.

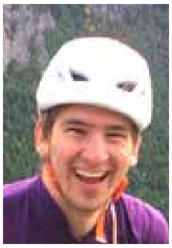
Wayne was born in Campbellton, NB, in 1955, and earned a degree in business administration from the University of New Brunswick before moving to Whistler in 1979 in pursuit of snow. He started working at Blackcomb Mountain as a ski instructor in 1980, joined the patrol team in 1984, and became an avalanche forecaster in 1989. He was a trauma paramedic, guided for Whistler Heli-Skiing and Extremely Canadian, and was a safety consultant for the film industry. As a member of Whistler SAR, he was leader in long-line rescue techniques. He was given the nickname "Wango" as people shouted "Go Wayne Go" as he sped down mountains on his skis.

He launched his blog in 2011 as a source for local snow, weather, and avalanche information; as well as avalanche news from around the world. It quickly became essential reading for backcountry enthusiasts in the Sea-to-Sky region and beyond.

"For the empowered, discerning avalanche information consumer, Wayneflannavalancheblog.com is a daily must-read," wrote Ryan Bougie when he nominated Wayne for the CAA Service Award. "Whether you're a seasoned reader or going to take your first few clicks after reading this submission, I think we owe some gratitude to Wayne Flann for his tireless efforts towards avalanche safety."

Wayne's impact on the Whistler and Canadian snow and avalanche communities is immeasurable. His death was met by an outpouring of grief, and a celebration of life on December 1 filled the banquet hall at the Fairmont Chateau Whistler.

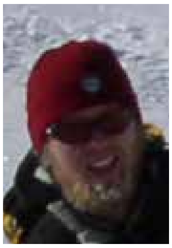
Remembering **Marcus Wybrow**



CAA member Marcus Wybrow died tragically in an avalanche while ice climbing in Kananaskis Country in November. Marcus was born in Hamilton, Ont., in 1994 and moved out west in 2017 to enter the adventure studies program at Thompson Rivers University, earning his diploma in 2017. He was a CAA Avalanche Practitioner, and Apprentice Rock Guide and Apprentice Alpine Guide with the ACMG. He was a climbing instructor and taught Avalanche Skills Training Courses.

On Nov. 11, 2023, Marcus and his partner were on their way down from a climb when they were struck from an avalanche from above. His passion and skills will be deeply missed.

In Memoriam: **Chris Borsta**



Chris Borstad, a former CAA Avalanche Practitioner and avalanche researcher, died on Nov. 15, 2023, at the age of 45 after a nearly four-year battle with brain cancer. Chris was born in Sheboygan, Michigan, in 1978, and grew up in Fort Collins, Colorado. He was a star researcher at the University of British Columbia's Department of Civil Engineering, where he undertook his graduate studies under Dr. David McClung. He completed his masters degree in 2005, researching runout dynamics and flowing speed of extreme avalanches. In 2011, he completed his PhD, where he investigated the quasi-brittle fracture and damage mechanics of dry snow slabs related to avalanches.

Following his graduate studies, Chris enjoyed stints at Nasa's Jet Propulsion Laboratory, Caltech, and University Centre in Svalbard, Norway. He joined Montana State University's civil engineering department as a tenure-tracked professor in 2016, where he taught snow science and researched avalanche fracture mechanics. He directly influenced recent avalanche related graduate research efforts in Canada around the blade hardness gauge; and other graduate research in the U.S. He was a contributor at the CAA spring meetings and a member from 2016 to 2021. He was diagnosed with brain cancer in March 2020. He died following further complications in November.

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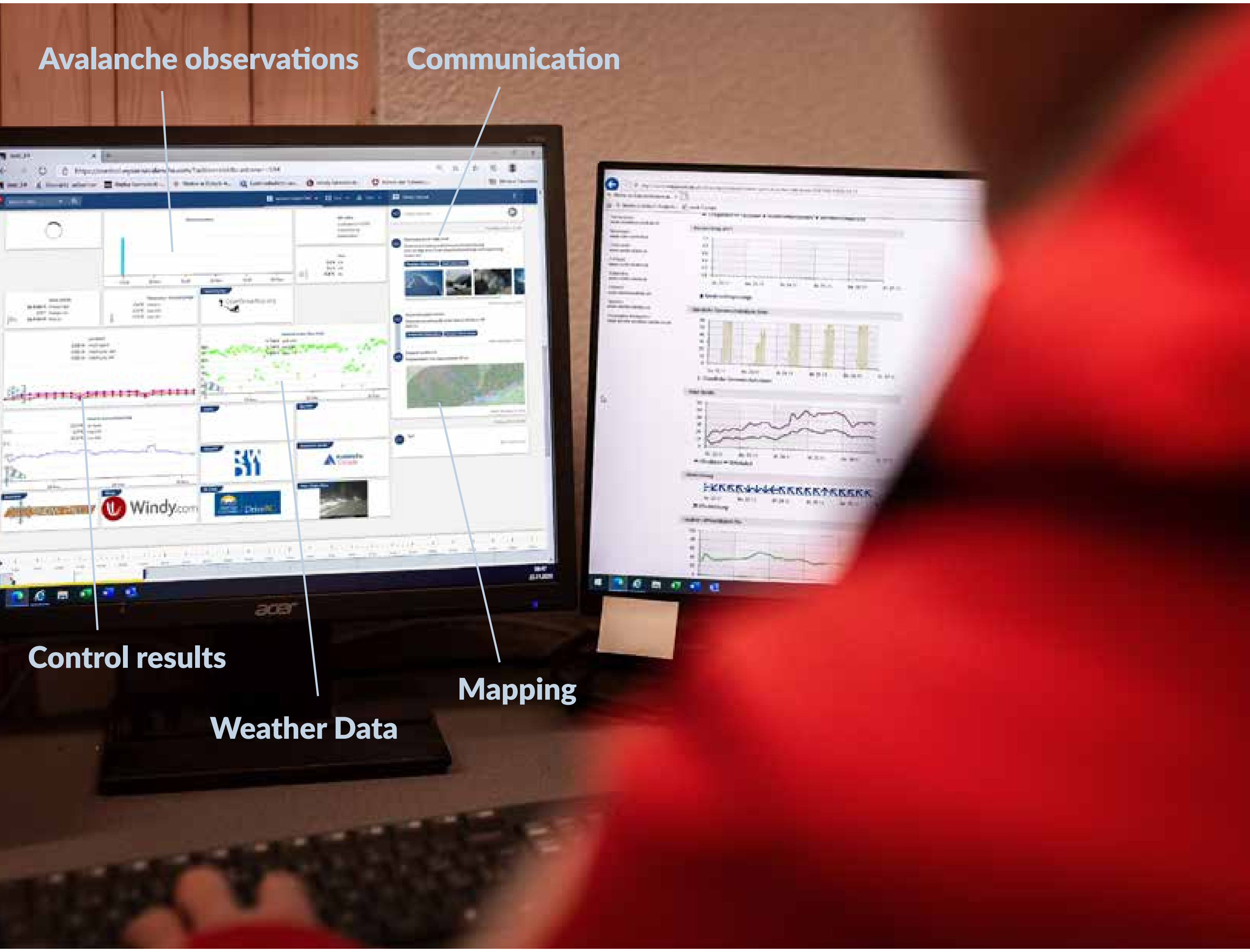

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