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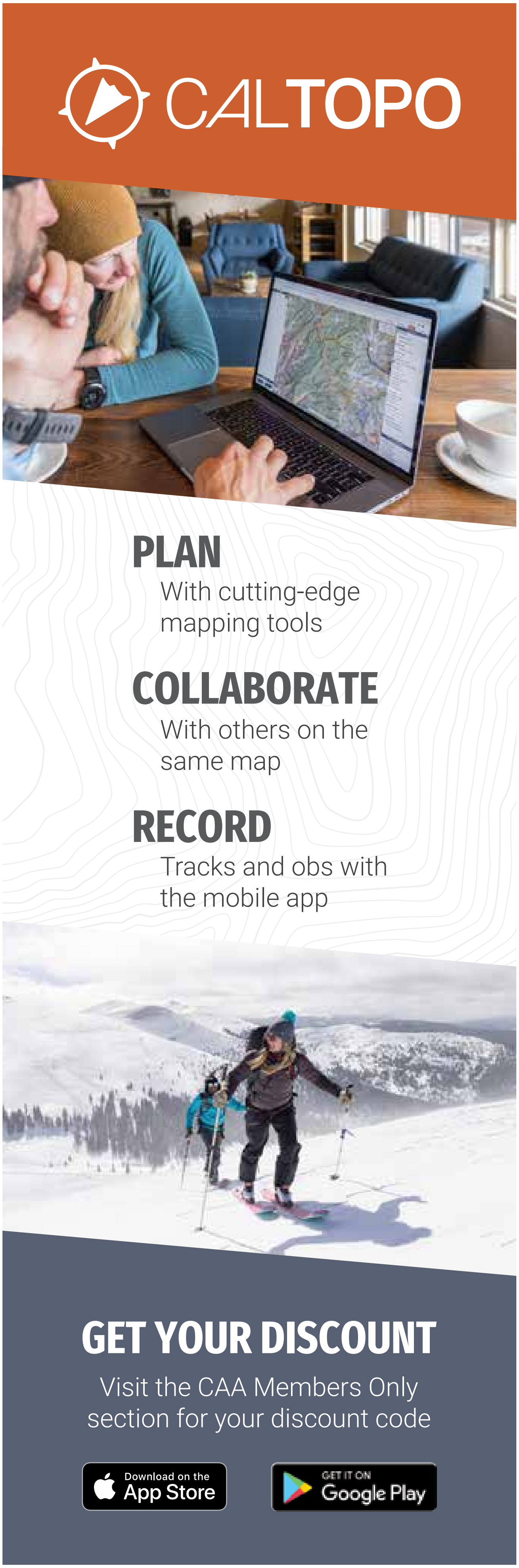
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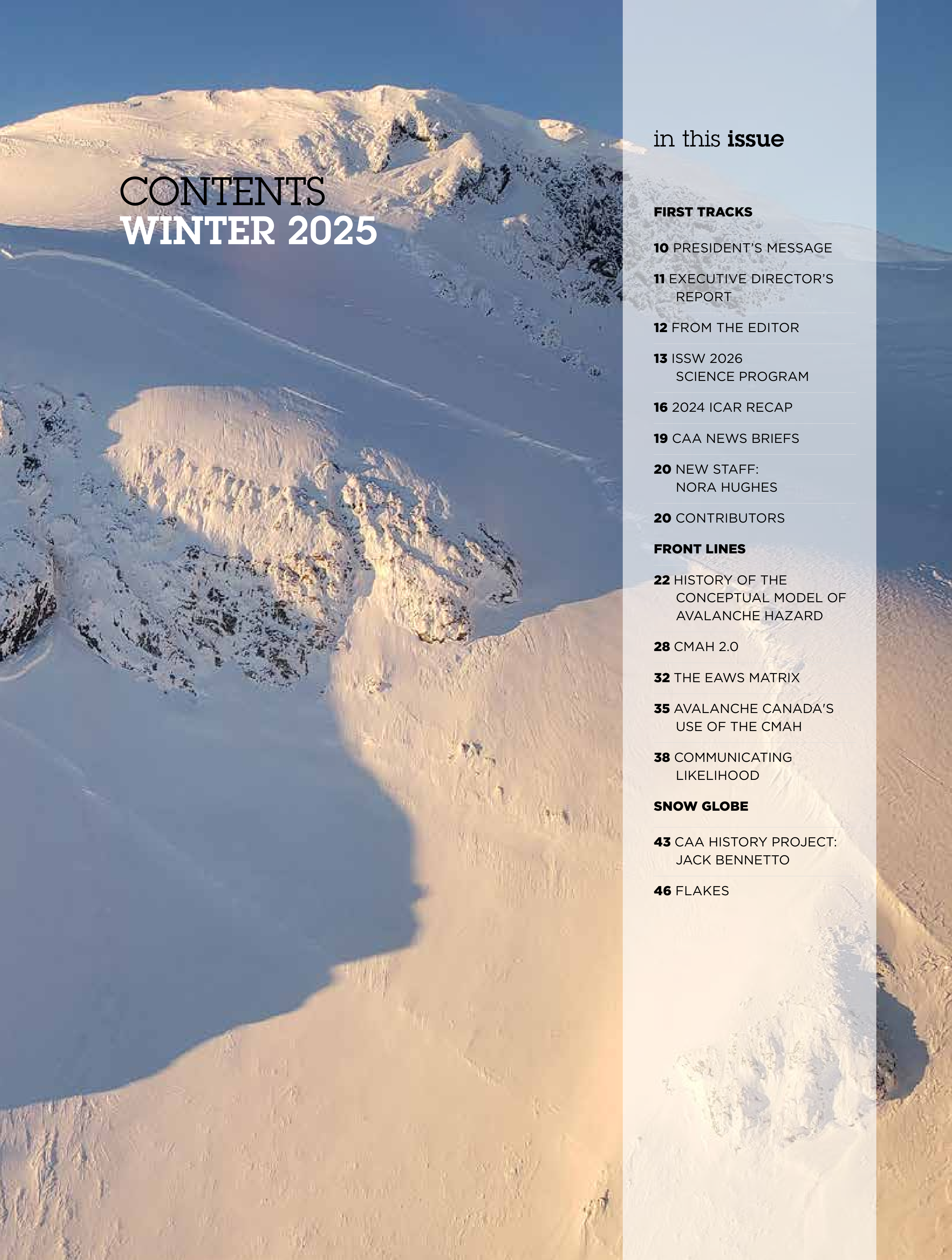

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WINTER 2025

in this **issue**

Eirik Sharp
CAA President

CAA President's Message

OUR PAST, PRESENT, AND FUTURE

WHILE YOU'LL likely be reading this article well into winter, I'm writing it fresh into the start of the new year. With that in mind, I hope you'll indulge me as I take a moment to consider where we stand, what we've achieved, and where we're headed as an organization.

I want to begin with a call to action. This year, we'll be bidding farewell to several long-serving board members whose terms are ending, including Jesse Percival, our Treasurer, and Kate Snedeker, one of our public representatives. A heartfelt thank you to both of you for your dedication, time, and commitment. Your contributions have been instrumental in shaping the CAA we know today.

In total, six director positions will be up for election at this year's AGM. If you've ever considered getting involved at the board level, now is a great time. We're looking for members with fresh ideas and a willingness to contribute. While it's a significant responsibility, it's also an opportunity to help shape the future of the CAA and the broader avalanche community.

For our public representative position, we're seeking an individual with experience in advocacy, the legal field, governance, or professional self-regulation. Previous board experience is an asset. If you know someone who might be a great fit, please connect them with Joe Obad or myself.

On the topic of governance, one ongoing challenge for our organization is managing perceived and potential conflicts of interest. While we maintain a strong track record in this area, the interconnectedness of our industry can sometimes make governance more complex. The board has been actively working to update our conflict-of-interest procedures, recognizing that while conflicts can't always be avoided, they can and should be managed effectively. Our goal is to strike a balance by implementing clear, ethical processes that allow us to make decisions that are functional, fair, and transparent.

We are also working with the Ethics and Standards Committee to refine scope-of-practice statements for Avalanche Professionals and Practitioners. Clear scope-of-practice statements define roles, ensure accountability, and, most importantly, build public trust. They're essential for ensuring we operate in safe, ethical, and competent ways as a self-regulating profession.

Another focus this year is exploring how to provide Avalanche Educator members with voting rights within the association. These members play a critical role in our community, and we believe their voices should be formally recognized at the governance level. We're developing a model for this, which we hope to present as a special resolution at the upcoming AGM. While there's still a lot of work to do, we're excited about the potential impact of this change. There will be an opportunity for comments from the membership, so please stay tuned for more updates in the months ahead.

On the membership front, launching a health and benefits package for members, developed in partnership with the ACMG, is a huge win. This is a big step forward in supporting the well-being of avalanche workers. We understand the challenges of the job—physical, mental, and financial—and this initiative is one way we're working to provide meaningful support. A huge thank you is owed to our Operations Manager, Rosie Denton, for her initiative and leadership in making this happen.

On a more operational note, Chris Ague and the Explosives Advisory Committee (EAC) have proposed developing standalone guidelines for helicopter avalanche control. Following several high-profile incidents and near-misses, the board agrees this is an opportunity to establish consistent industry-wide practices. We are moving forward with this initiative, which we hope will enhance safety and standardize procedures for helicopter-based operations.

Lastly, the *Observation Guidelines & Recording Standards for Weather, Snowpack and Avalanches* (OGRS) update has been completed. This long-awaited project provides members with an essential resource to access the latest tools and guidance.

There's always more work to be done, and none of it would happen without the dedication of our members. Whether it's running for the board, joining a committee, or sharing your ideas, there are many ways to get involved. Your contributions help keep the CAA relevant, effective, and grounded in the realities of the avalanche world.

As always, I'm available to answer your questions, hear your concerns, or discuss anything CAA-related. Feel free to reach out anytime at president@avalancheassociation.ca.

Here's to a safe and productive year ahead!

Eirik Sharp, President

Joe Obad
CAA Executive Director

Executive Director's Report

CAA MEMBERSHIP: TAKING STOCK

RECENTLY, I found myself reviewing the membership forum, where staff, paid reviewers, and the Membership Committee swiftly work through membership applications. So much recent work went to ensuring these processes are rigorous and meet the needs of applicants.

As much as I am thankful for all recent efforts by staff, committee, and subject matter experts, my gaze turned not to 2024 alone, but back to 2014. That was the year the CAA, under Past-President Aaron Beardmore, embarked on the bold path towards competency-based membership.

The first steps roughly coincided with ones taken by WorkSafeBC, the province's occupational health and safety regulator. In 2015, in the wake of the battles to enact regulations to protect workers from avalanche hazard, WSBC settled on a version of Regulation 4.1.1, that stated, "avalanche risk assessment must be conducted by a qualified person." 'Qualified' was defined as "knowledgeable of the work, the hazards involved and the means to control the hazards, by reason of education, training, experience or a combination thereof."

That broad definition presented an opportunity for us to define membership competencies addressing avalanche work, associated hazards, risk, and mitigation in a way that aligned the work of its members with its primary regulator, ensuring a place in B.C.'s working landscape.

In 2014, the CAA formed a Competency Working Group that included Aaron Beardmore, Colin Zacharias, Troy Leahey, Andrew Nelson, Doug Wilson, Dustin Thatcher, Walter Bruns, Jim Phillips, and consultant David Cane. They developed the initial competency profiles for what are now Avalanche Professionals and Avalanche Practitioners.

The profiles defined key aspects of work environments such as levels of supervision and independence. They broke down competencies into more objective work such as applying OGRS and subjective elements such as avalanche risk assessments. The group also laid the foundations for competencies in professionalism, which were defined further in the course that was eventually rebranded as "Professionalism in the Avalanche Industry."

The working group set the stage for revising Avalanche Operations Level 1 and Level 2. Former ITP Manager Emily Grady and Colin conducted a gap analysis to see how the courses must be changed to match the competency profiles. SAR NIF funding was obtained to overhaul the courses, and we spent the next few years making changes.

In 2019, Kathy McKay was hired to finalize work on the courses and create the first iterations of the membership process. She was amazing and accomplished exactly what we asked of her, but through no fault of her own, it wasn't quite right. A world of growing pains and lessons were about to come our way. Members were positive about the process during consultation, but as we learned the hard way, folks' attention sharpens when processes or policies bear directly on their needs.

As the first wave of applicants struggled in 2020, we received our first real feedback. For industry veterans, the process was a challenge. Guides, for example, were being pushed to prove a long list of competencies they believed were met through their existing certifications, but for which the process offered insufficient recognition. Concurrently, the Avalanche Practitioner competencies created challenges for applicants not coming from traditional environments like ski hills. Developing your skills through snowmobiling? Trying to build your career far from the mentorship opportunities between Calgary and Whistler? We didn't have solutions for these situations.

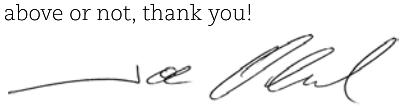
Applications also faced long processing times from a volunteer committee. They were evaluated rigorously, but not quickly. Obviously, we needed to improve.

Fortunately, we were blessed with Kerry MacDonald's leadership as Membership Committee Chair and Rosie Denton's emergence first as Membership Coordinator and later as Operations Manager. They made vital reforms.

Paid reviewers would conduct the heavy initial reviews and pass on outstanding questions and final review to the Membership Committee. They worked with partner associations to recognize certifications and pushed applicants for evidence of competencies only where recognized training was absent. This process started with the ACMG and has expanded to include the CSGA and our snowmobile friends at the Canadian Motorized Backcountry Guides Association.

Concurrently, we developed the Basic and Advanced Avalanche Educator categories to help meet the demand for avalanche education. These categories were approved at the May 2023 AGM and have provided accessible membership for educators, whose practice is limited in scope. The herculean effort of ITP Manager Maris Fraser, Curriculum Specialist Chris Dyck, the ITP team, and many SMEs to get courses up to support these categories is its own tale!

The process isn't perfect, and we'll continue to adjust as needed. For now, let's thank the many folks who, since 2014, put their shoulder to the wheel to reshape and improve CAA membership and training to meet the needs of our industry. If you helped in any way small or large, whether you're named above or not, thank you!



Joe Obad, CAA Executive Director

Alex Cooper
Managing Editor

From the Editor

THE CONCEPTUAL MODEL

THIS ISSUE OF *The Avalanche Journal* takes a special look at The Conceptual Model of Avalanche Hazard. Development of the CMAH began about 20 years and it has been embedded into the avalanche forecasting workflow in Canada for over a decade. The genesis of this issue was an article Scott Thumlert sent me back in the summer of 2023 that proposed ways to evolve the CMAH. At ISSW 2023 in Bend, it was mentioned in several oral and poster presentations.

It struck me there that it would be interesting to take a look at the Conceptual Model in *The Journal*, and perhaps spark a conversation on its future evolution. As Grant Statham, the lead author on the original paper told me: "These things need to evolve… but you need some pretty broad consensus to do that."

As an editor and word nerd, one thing that caught my eye as I assembled this issue was how we refer to it as *"the"* Conceptual Model of Avalanche Hazard. Grant Statham's 2010 ISSW paper, co-authored by nine other giants of the industry, which introduced the CMAH to the world, featured the headline *"A" Conceptual Model of Avalanche Hazard*. So does the 2018 peer-reviewed paper published in the journal *Natural Hazards and Earth Systems Sciences*.

To me, it speaks to how important this work has been that we simply refer to it as "The Conceptual Model." It's not just "a" conceptual model. In the avalanche industry, mention "The Conceptual Model," and there's no confusion as to what you're talking about. Notably (to me and maybe a few other writing style aficionados reading this), I also chose to capitalize it. This might seem normal to some, but I can say it goes against my editorial instincts, which eschews capitalization unless my trusty Canadian Press Stylebook says so. Sometimes the book isn't crystal clear, so you make an exception—this is one of them.

The section on the Conceptual Model begins with an interview with Grant Statham on the development, evolution, and future of the CMAH. We spoke for about 40 minutes and quite a bit had to be edited out to fit in the magazine. I'll be posting the full interview on *avalanchejournal.ca* and I highly recommend you check it out.

The second article is the aforementioned one by Scott Thumlert, which is boldly headlined CMAH 2.0. In it, Scott argues: "Establishing the link from the assessment framework detailed in the CMAH to operational hazard ratings suitable for professionals is the next logical step."

Another article by Norwegian avalanche forecaster Karsten Müller looks at the European Avalanche Warning Service Matrix, and the influence of the CMAH in the new hazard assessment tool used by public avalanche warning services across Europe. James Floyer, the Program Director at Avalanche Canada, looks at how our public warning service has used the CMAH and concludes with a discussion on how snowpack models might influence future developments. Finally, Andrew Schauer, Lead Forecaster for the Chugach Avalanche Center in Alaska, talks about the challenges with communicating likelihood to recreationists.

This issue only scratches the surface. One article that didn't make this issue for reasons of time is Stian Langeland's proposal for a conceptual model for site-specific avalanche forecasting, which was presented at ISSW 2023. Another is Scott Thumlert's proposed scale for the likelihood of avalanches, which was presented at ISSW 2024. I recommend searching for those papers at Montana State University's online library of ISSW proceedings papers. Most notably, this issue doesn't look at avalanche problems, which are arguably *the* key component of the CMAH. I acknowledge this is an omission, but avalanche problems could be the subject of a future issue of their own.

If you have your own thoughts on The Conceptual Model of Avalanche Hazard (or any other avalanche-related topic) and wish to share them, I encourage you to send a letter to the editor to acooper@avalancheassociation.ca.

Alex Cooper, Editor

ISSW 2026 Whistler
Message from the Scientific Committee

Scott Thumlert, Chair of ISSW 2026 Science Committee

THE INTERNATIONAL SNOW SCIENCE WORKSHOP is returning to Canada in 2026, with Whistler hosting the conference. The Organizing Committee of Nicole Koshure, Tim Haggerty, and Jerome David has been hard at work, securing the Whistler Conference Centre as the venue, and Wyssen and Arcteryx as Title Sponsors, which are core parts for an unreal week. The Safety Sponsors are MND and CIL, and the key Supporting Sponsor is the Canadian Avalanche Association.

The Scientific Committee (Chris Argue, Simon Horton, Curtis Pawliuk, Scott Thumlert) is dedicated to continuing the ISSW motto of "merging theory and practice." We want to provide practitioners with opportunities to share their experience alongside scientists presenting the leading advances in snow and avalanche research. We aim to make the program approachable and engaging for as many attendees as possible, while maintaining scientific rigor, ensuring ISSW remains a credible platform for presenting and exchanging state-of-the-art scientific research. Our goal is to seamlessly balance theory and practice throughout the conference.

To contribute to the scientific program the basic workflow is:

- Early-May 2026: Submit your abstract
- Early-July: Receive notification of what presentation session you are awarded
- Late-August: Submit your technical or descriptive paper
- ISSW 2026: Present!

THE PROGRAM

We have created a draft of a dynamic scientific program that builds on successful past conferences, highlights emerging areas of practice, and merges theory and practice. The program consists of five key presentation types:

- **Advances in Understanding:** These sessions provide the opportunity to present and learn about the newest leading-edge scientific findings. Ideally, we will all be enlightened with new knowledge, take away some wisdom to improve our practice, and become motivated to contribute to the frontiers of our understanding of snow and avalanches.
- **Avalanche Risk Management:** These sessions will revolve around a core avalanche risk management sector (e.g. transportation corridors, ski resorts, backcountry guiding, public forecasting). Each session will kick off with a practical presentation that showcases an operational avalanche risk management program (e.g. Rogers Pass), highlights the core challenges, and sets the stage for how and where research and theory may help. The remaining presentations will stem from traditional scientific ISSW topics (e.g. snow cover modelling, dynamics, planning and engineering), that have some application or connection to the core operational challenges highlighted in the kickoff presentation. This concept will unite theory and practice while maintaining the thread of the session by:
  - moderators establishing and maintaining the core theme of the session,
  - presenters tying their work to the core theme,
  - attendees following the core theme through scientific presentations that link to a practical application, and
  - the Scientific Committee selecting and guiding the theoretical topics into a session that maintains a clear connection to the core operational challenges.
- **Poster Sessions:** The poster sessions are the perfect relaxed setting to engage with both the work and its creators. The social setting will stimulate discussions, networking, and the ultimate merging of theory and practice. These sessions will be organized around traditional ISSW topics such as education, decision-making, risk communication, and remote-sensing.
- **Focus Sessions:** These afternoon sessions will focus on emerging or specialized sectors of the avalanche profession and will run concurrently to separate panel discussions. The topics of these sessions are currently: 1) Snowmobile and Motorized, 2) Sustainability, 3) Weather Forecasting and Climate; and 4) Remote Sensing and Drones. The topics may change depending on the submissions.
- **Panel Discussions:** Who doesn't love a hotly contested debate on a fascinating topic in a smaller venue? The Rainbow Theatre holds a maximum of 250 people and provides the perfect arena for these discussions. The current topics include: 1) Ice Climbing Avalanche Risk Management, 2) AI in the Avalanche Profession, 3) Evolving Explosive Use Practice, and 4) Big Line Riding. As with the Focus Sessions, these topics may change.

	Sun	Monday	Tuesday	Wed	Thursday	Friday
630 - 745	Welcome and Icebreaker	Speaker's Breakfast	Speaker's Breakfast	Public Day, Field Trips, and Get Outside Day	Speaker's Breakfast	Speaker's Breakfast
800		Opening Words (0800 - 0815)	Opening Words (0800 - 0815)		Opening Words (0800 - 0815)	Opening Words (0800 - 0815)
815 - 945		Advances in Understanding 1 **Snow Avalanche Formation and Release** (0815 - 0945)	Advances in Understanding 2 **Crack Propagation and Fracture Mechanics** (0815 - 0945)		Advances in Understanding 3 **Avalanche hazard, risk, forecasting** (0815 - 0945)	Advances in Understanding 4 **Terrain, Hazard Mangement in the Field, Decision-Making** (0815 - 0945)
-		AM Break (0945 - 1015)	AM Break (0945 - 1015)		AM Break (0945 - 1015)	AM Break (0945 - 1015)
1000 - 1130		Avalanche Risk Management 1 **Transportation Corridor Challenges** (1015 - 1130)	Avalanche Risk Management 3 - **Public Avalanche Risk Management** (1015 - 1130)		Avalanche Risk Management 5 **Backcountry Guiding Challenges** (1015 - 1130)	Avalanche Risk Management 7 **Large Destructive Avalanches** (1015 - 1130)
-		Lunch Break (1130 - 1300)	Lunch Break (1130 - 1300)		Lunch Break (1130 - 1300)	Lunch Break (1130 - 1300)
1245 - 1415		Avalanche Risk Management 2 **Public Forecasting 1 Communication** (1300 - 1415)	Avalanche Risk Management 4 **Ski Resort Management** (1300 - 1415)		Avalanche Risk Management 6 **Public Forecasting 2 Hazard and Risk** (1300 - 1415)	Avalanche Risk Management 8 **High End Mountain Performance + Film** (1300 - 1415)
-		PM Break (1415 - 1445)	PM Break (1415 - 1445)		PM Break (1415 - 1445)	PM Break (1415 - 1445)
1445 - 1600		Focus Session 1 - **Snowmobile and Motorized** (1445 - 1600) Panel Discussion 1 **Ice Climbing Avalanche Risk Management** (1445 - 1600)	Focus Session 2 **Sustainabilty** (1445 - 1600) Panel Discussion 2 **AI in the Avalanche Profession** (1445 - 1600)		Focus Session 3 **Weather forecasting + climate** (1445 - 1600) Panel Discussion 3 **Evolving Explosive Use Practice** (1445 - 1600)	Focus Session 4 **Remote Sensing and Drones** (1445 - 1600) Panel Discussion 4 **Big Line Riding** (1445 - 1600)
- 1800		Poster Session 1 and Happy Hour (1600 - 1800)	Poster Session 2 and Happy Hour (1600 - 1800)		Poster Session 3 and Happy Hour (1600 - 1800)	Poster Session 4 and Happy Hour (1600 - 1800)

A DRAFT SCHEDULE FOR THE ISSW SCIENCE PROGRAM.

REVIEW SYSTEM

For those unfamiliar, folks interested in presenting at ISSW will be required to submit an abstract—basically an outline of what they would like to present. The abstracts will be reviewed and ranked by a large group of reviewers who will follow a set process. These reviews will determine which presentations are selected for the oral sessions and how they will be arranged into the program. We have approximately 110 oral presentation slots and anticipate over 450 submissions.

We plan to have two or three reviewers rank each abstract based on these criteria: 1) merging of theory and practice, 2) scientific quality, 3) practical application, 4) innovation, and 5) overall score. The highest ranked abstracts will then be slotted into the program based on the session type and topic. Understanding what sector your study applies to (e.g. transportation corridors, public warning services, ski resort management) and then framing the abstract to make that connection will likely mean a higher chance at an oral presentation. Of course, many (most?) studies and presentations are well suited for poster presentations, so this ranking system should not be misinterpreted to say that orals are better than posters.

Lastly, the Scientific Committee is actively seeking reviewers, so please reach out to scientific.committee@issw2026.com to be added to the reviewer list. Reviewing abstracts is an excellent opportunity to get more involved with the conference and it provides an opportunity for continuing professional development.

PAPER OPTIONS

A core goal of both the Organizing and Scientific Committees is to receive more high-quality presentations from practitioners. We realize one of the key obstacles for practitioners to contribute more formally has been the requirement to submit a paper to the conference proceedings. We have a few strategies to tackle this:

A. We are planning to have two options for preparing papers: 1) standard ISSW paper format (typically best suited for more technical work), and 2) descriptive format (best suited for more practical descriptions of operations, case studies, or discussion). We will provide one or two example templates for each option to help guide the process.

B. The students at the Simon Fraser University Avalanche Research Program led by Pascal Haegeli have graciously agreed to help practitioners with their papers. Ideally, this connection will give the future core members of our profession contact with the current state of the profession and alleviate some of the barriers writing a paper may present. Details of how to connect will become available closer to the conference.

We really encourage practitioners to step up and get their ideas into the mix.

TECHNICAL FIELD TRIPS AND PUBLIC SNOW AND AVALANCHE WORKSHOP DAY

We are planning to organize some technical field trips, as well as provide recreational activities for the Wednesday of the conference. A field trip highlighting the avalanche control programs at Whistler Blackcomb is already in the works. Please reach out to scientific.committee@issw2026.com if you have a good idea for a technical field trip highlighting avalanche risk mitigation.

That day, there will also be a concurrent Public Snow and Avalanche Workshop at the conference centre. The public day will be put on in partnership with Avalanche Canada and show presentations focused on avalanche risk management and education for the public sector. We hope to take advantage of the expertise of the professional attendees for this event. This is a great opportunity for professionals to reach the greater snow and avalanche community, especially on topics that pertain more to the public such as avalanche forecasting and education. We anticipate a huge amount of interest from the local Sea-to-Sky backcountry community for this event. Our aim as organizers is to create an annual snow and avalanche workshop as a legacy of hosting ISSW 2026. If you are interested in presenting on this day please email nicole@issw2026.com with your topic idea.

YOUNG SNOW PROFESSIONAL AWARDS

Continuing the excellent initiative to support and encourage young practitioners and researchers started at ISSW Innsbruck in 2018, we plan to offer up to 10 Young Snow Professional Awards. These awards will waive the conference registration fees for selected up-and-coming professionals in the early stages of their careers. We ask that the application and selection process be managed by national avalanche associations (e.g. Canadian Avalanche Association, Austrian Association for Snow and Avalanches). Participating associations should:

- design their application criteria,
- accept and evaluate applications,
- select an award winner; and
- provide mentorship for preparation of the abstract, paper, and presentation.

Please reach out to the Scientific Committee at scientific.committee@issw2026.com if your association is interested in supporting a young snow professional in your membership. We will only be able to offer five to 10 awards, so we will use a first-come-first served process to select interested associations.

GRANT STATHAM PRESENTS AT ISSW 2023 IN BEND, OREGON. ATTENDEES OF ISSW 2026 IN WHISTLER CAN EXPECT OVER 100 ORAL PRESENTATIONS AND MANY MORE POSTER PRESENTATIONS FOCUSED ON THE LATEST RESEARCH, RISK MANAGEMENT, AND MORE. // ALEX COOPER

2024 International Commission for Alpine Rescue Recap

Observations and Findings for Rescuers, Educators, and Public Outreach

Mike Koppang

THIS PAST OCTOBER, I had the privilege of attending the International Commission of Alpine Rescue (ICAR) congress in Thessaloniki, Greece, on behalf of the Canadian Avalanche Association. ICAR has five separate commissions that work on aspects of rescue-related work and make recommendations to the international rescue community: Terrestrial, Air, Medical, Dog and Avalanche Commissions.

I focussed on the Avalanche Commission and the learnings and recommendations from this group. I was given the opportunity to present on the Auto-Avalanche Terrain Exposure Scale (ATES) map in use in Kananaskis Country and its use in public risk communication. I also was a panelist in a discussion on the relationship between forecasters and rescuers in different countries.

The congress started with a heavy day of reports on fatalities and responses. Much of the focus was on professional rescue response, highlights, and challenges or trends. Jennifer Coulter from Avalanche Canada presented a summary of Canadian incidents from the winter of 2023/24.

What quickly became apparent is different countries have different user groups that tend to account for a higher number of incidents. New Zealand search and rescue found 70% of their avalanche fatalities involved mountaineers, while in Italy mountaineers only accounted for 23% of incidents.

Accordingly, different communication strategies are used to target specific user groups more affected by avalanche risk. In Canada, we have been doing this for some time. An example is trying to speak more directly to snowshoers, who unknowingly find themselves in avalanche terrain. Canadian forecasting agencies and local SAR groups have worked together to prepare educational content targeting varied user groups recreating in the same region. Conversely, while Italy may see fewer mountaineering accidents, they are seeing more snowshoe-related accidents. It was good to share how we have been targeting communication and education efforts, and to learn strategies from other countries to enhance our work in Canada.

In the U.S., there has been a decreasing trend in avalanche-related fatalities. Like Canada, the majority of these avalanches have involved skiers and snowmobilers. Discussion revealed a common theme: the stuck snowmobile requiring the operator to get off their sled, often leading to others in the area coming to help and increasing the group's overall exposure time in avalanche terrain.

Overall, it seems fewer people are heading into avalanche terrain without avalanche safety gear. There is no way to fully confirm this trend, but rescue teams report responding to fewer incidents involving persons without avalanche safety equipment. Better communication to the public in education campaigns may be making a difference on this front.

During conversations during the breaks about communicating to specific groups, I often referenced the work done for ice climbers in Canada. Early-season targeted messaging and the creation of the Ice Climbing Atlas on *avalanche.ca* helped other forecasters understand some of the strategies we have used to reduce ice climbing incidents.

Despite these bright spots, alarming information emerged regarding five incidents where a transceiver was either torn off a person or damaged during an avalanche. In some instances, the transceiver became damaged and was no longer functioning, while in others, the other members of the party dug down to what they thought was a person, only to find just a transceiver. These incidents highlight the importance of wearing transceivers underneath clothing or in a place where they are not easily torn off. Two related cases involved airbags that inflated but became separated from the person. These incidents should catch the attention of our professional and recreational AvSAR educators. Emphasizing proper transceiver storage and air bag attachment should feature strongly in training.

Loss or absence of transceivers highlights other tools we have at our disposal such as RECCO, probe lines, and avalanche dogs, and our need to proficiently apply these techniques. The RECCO SAR helicopter detector system is currently available in three places in western Canada: Vancouver's North Shore, Vernon, B.C., and Canmore, Alta. This tool allows rescuers another resource to locate persons involved in an avalanche. It can also be used without having to expose rescuers to a slope that may have overhead or

MIKE KOPPANG PRESENTS ON THE USE OF AUTO-ATES MAPS IN KANANASKIS COUNTRY AND THE ASSOCIATED COMMUNICATION CHALLENGES. // JEN COULTER

other hazards. Not only can it locate a RECCO tag, but it has the potential to locate other pieces of electronics or circuits, albeit at a much lower range.

A handheld RECCO R9 unit was used in Bosnia following an avalanche and made an incidental find on what they suspect was the person's bank card. The rescue team was using the detector in smaller search strips while working alongside probe lines and avalanche dogs. Another subject was found alive near Chamonix with a handheld RECCO unit at a depth of 80 cm after 20 minutes of burial time.

While a handheld transceiver is generally easier to practice with in a variety of situations that can be quickly simulated, helicopter-based systems require more planning and budget for training. This topic was raised in a few ICAR meetings by different teams discussing the strengths and weaknesses of small professional teams and large volunteer groups.

The French PGHM team from Chamonix (which responds to around 1,200 calls per year) gave an excellent presentation about a large avalanche involving 15 people on Mt. Blanc that occurred at 3,400 m and was over 2,200 m long. The response involved two helicopters, three physicians, three dog handlers, and 25 PGHM staff. The talk focused on some of the strategies they have undertaken to build resilience into the team. They recognized helicopter RECCO and helicopter long-line rescue in technical terrain are advanced skills that involve working in a high acuity environment. Their strategy has been to train only a small number of people in these techniques, which allows certain staff to remain current and proficient, and helps reduce confusion amongst team members about roles. Training the entire team would be difficult due to costs and to maintain competency.

This resource or crew management comes with its own problems. It can build resentment between team members and in large events, availability of team members with that specific skill can be an issue. Staff turnover can also be challenging as people leave, and succession planning must be addressed. Regardless of the team's model, the takeaway was: "Train as you act and act as you train." If your team commonly responds in smaller groups, focus your training as such and be open to specializing different people based on their skill sets. Do not forget to consider larger events, and know your limitations. Once you know your limitations from either a staffing or technical skills point of view, it becomes easier to develop strategies to address these issues.

The key things to consider when responding to an avalanche burial are time (greater than or less than 60 minutes) and airway status. Interestingly, in 50% of responses to a fully buried person, the status of their airway was listed as unknown by the responding agency. This is understandable as it can be hard to accurately determine the status of a person's airway. The takeaway message is if you don't know, and other factors such as unsurvivable trauma have been ruled out, assume the airway is clear and initiate CPR.

Other important considerations are availability of mechanical CPR devices and the location of the closest medical facility with ECMO* capability. Pre-planning for additional medical care may lead to a positive outcome. Not every team can have access to a mechanical CPR device, so it's important to practice and be proficient in intermittent CPR.

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*Extracorporeal membranous oxygenation (ECMO) is the most effective rewarming method for patients who suffer from severe accidental hypothermia, and also is effective cardiopulmonary support for patients in cardiac arrest. *Rewarming for accidental hypothermia in an urban medical center using extracorporeal membrane oxygenation – NIH National Library of Medicine*

The review that resonated most was an avalanche that occurred in Italy on February 28, 2024. A group of four people, including one on snowshoes who was described as tired, stopped at a mountain "pasture." They weren't on their intended route and visibility was poor. It was warm and the group was wearing minimal clothing. An avalanche hit the group, burying three of the four individuals and resulting in one fatality.

A point that stood out was two of the victims were buried for two hours and survived. Their core temperature was 27 C when assessed on scene, which is considered severe hypothermia. A contributing factor to their survival was believed to be their minimal clothing, which possibly led to more rapid cooling and faster onset of hypothermia.

Many factors resonated with this call in terms of teaching and learning opportunities. How are we talking about and teaching terrain? How are we teaching medical management and call response? How are we thinking about not just the response, but being part of the chain of survival in the greater health care system? These are all important points to consider when looking at the bigger picture of avalanche response and education.

In Canada, we are fortunate to have different agencies working together on avalanche education and response. As I looked around the room, I saw CAA members participating and attending meetings in every commission, and teaching at two different workstations during the field day. I was proud to represent the CAA in a presentation regarding Auto-ATES to the Terrestrial, Dog, and Avalanche Commissions, and participate in a panel discussion with Swiss, French and Swedish forecasters and responders on, "How do forecasters and rescuers intersect."

The Avalanche Commission continues to work on additional recommendations to rescue teams working in avalanche response. In the next *Avalanche Journal*, I will write more about some of the recommendations we are working on and some that recently passed.

Note from the Board of Directors: Mike Koppang was invited by ICAR's Avalanche Commission to present on ATES mapping and risk communication in Kananaskis Country. Mike asked the Board for support covering his expenses to attend ICAR. The Board supported Mike's participation on condition that he write the article presented here and prepare a report to the Industry Training Program on current AvSAR best-practices at ICAR that ITP may wish to investigate to improve AvSAR courses. Both the conditions were met, allowing reimbursement of Mike's ICAR expenses.

THE CANADIAN CONTINGENT AT ICAR 2024 IN THESSALONIKI, GREECE. // JEN COULTER

CAA News Briefs

NEW BENEFITS PLAN FOR MEMBERS

The CAA is pleased to offer an exclusive extended health and dental plan for members through our partners, Acera and Simply Benefits. The plan is optional, and part of a partnership with the ACMG.

Gold and Silver plan options are available, allowing Members to choose the benefits that suit them best from extended health care, dental, vision, paramedical, prescription drugs, life insurance, and travel insurance. Coverage is available for individuals, couples, and families.

For more information, pricing, and to review the plan options, visit avalancheassociation.ca/page/ExtendedHealthandDentalPlan

MOUNTAIN WEATHER FORECAST FEEDBACK

We have learned that the Mountain Weather Forecast, which is produced by the Meteorological Services of Canada and hosted by Avalanche Canada, will no longer be offered following this winter.

MSC has explained that these adjustments align with their strategic direction and sustainability goals, consistent with what they provide to other public safety bodies in Canada. Avalanche Canada is now faced with the challenge of addressing the impending gap created by the loss of the MWF.

Anyone concerned about this decision is requested to provide feedback to MSC. For more details and information on how to provide your own input on the impacts of this decision, visit mailchi.mp/avalancheassociation.ca/mountain-weather-forecast.

NEW MENTORSHIP FORUM

The CAA launched a new Mentorship Forum this fall. The forum is designed to facilitate valuable mentorship opportunities for members within the CAA community.

Members at all career levels can seek mentorship, and/or provide guidance to their colleagues coming up in the industry. We encourage you to get involved. It can be accessed through the Member's Only page of the CAA website.

FIND US ON SOCIAL MEDIA

Did you know the CAA is now on social media? We launched Facebook, Instagram, and LinkedIn pages in the fall. Search for "Canadian Avalanche Association" on any of those platforms to get our updates directly in your feed.

FUTURE AVALANCHE WORKERS TAKE PART IN ONE OF THE FIRST AVSAR LEVEL 1 COURSES AT REVELSTOKE MOUNTAIN RESORT IN DECEMBER 2024. THE NEW COURSE IS A PREREQUISITE FOR AVALANCHE OPERATIONS LEVEL 1. MORE THAN 300 STUDENTS HAVE ENROLLED IN THE COURSE THIS YEAR. // MARIS FRASER

Contributors

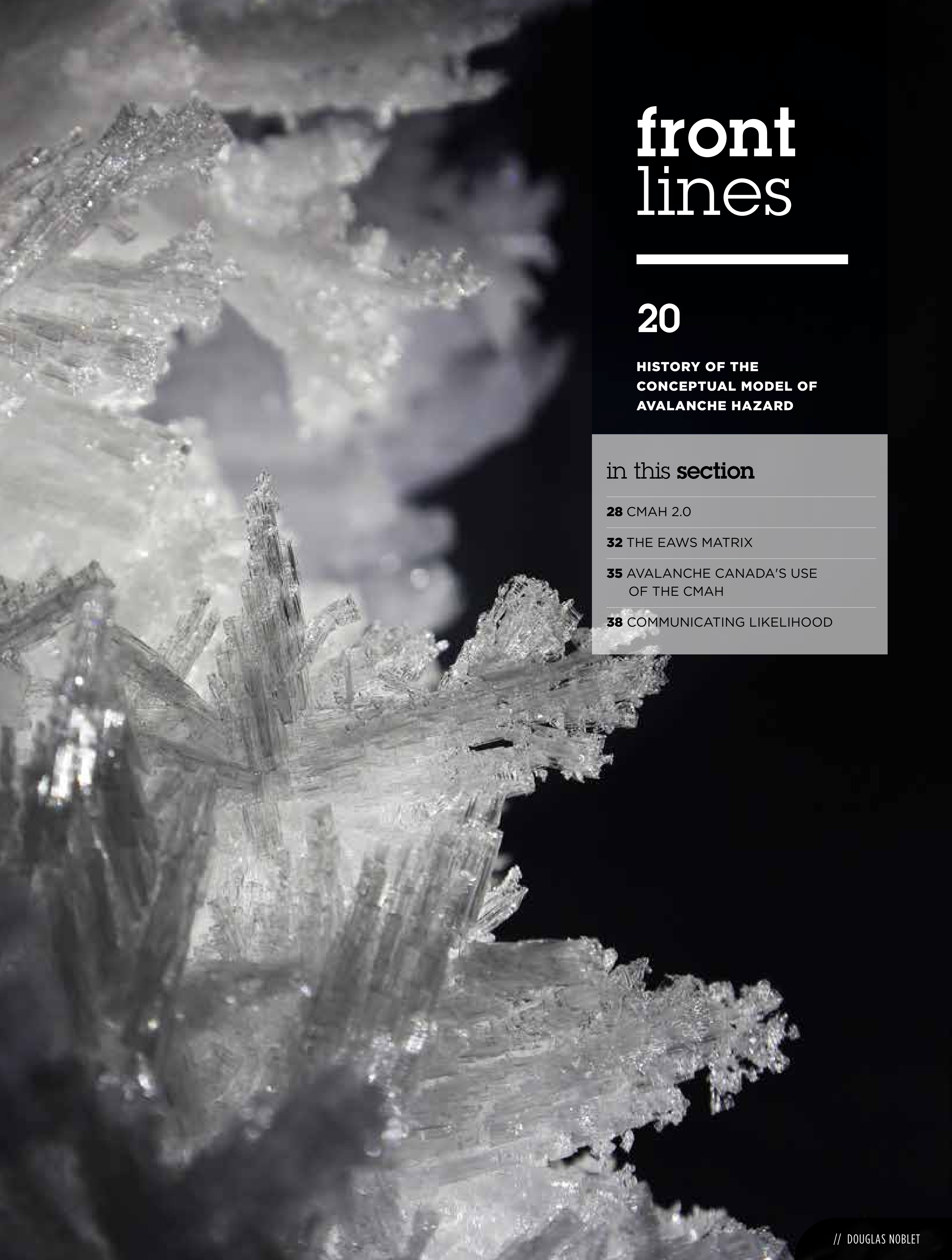
KARSTEN MÜLLER
Karsten Müller is a researcher and avalanche forecaster at the Norwegian Water Resources and Energy Directorate, which hosts the Norwegian Avalanche Warning Service. Karsten has a PhD in geophysics from the University of Oslo. He has been involved in setting up Norway's avalanche warning service and related research projects. Karsten has been the head of the Matrix & Scale working group within the European Avalanche Warning Services since 2017.
32 THE EAWS MATRIX

JAMES FLOYER
James Floyer is the Program Director for Avalanche Canada. James has been with AvCan since 2008 and worked for many years as an avalanche forecaster. James holds a Master's degree from UBC and a PhD from the University of Calgary's Applied Snow and Avalanche Research Centre. James sits on the Technical Committee and teaches weather courses for the CAA. He lives in Revelstoke with his wife, two kids, and two cats.
35 AVALANCHE CANADA'S USE OF THE CMAH

ANDREW SCHAUER
Andrew Schauer is the lead avalanche forecaster for the Chugach National Forest Avalanche Center in Girdwood, Alaska. He spends his summers in Livingston, Montana, and has developed an addiction to British Columbia singletrack during his biannual commute between AK and MT in the spring and the fall.
38 COMMUNICATING LIKELIHOOD

New Staff: **Nora Hughes, ITP Support**

Nora Hughes has joined the CAA in the new position of ITP Support. Originally from Massachusetts, Nora made the move to Canada to continue a university program she'd started in Iceland. With a background in journalism, communications, and program coordination, she brings a diverse skill set to her new role. When not supporting ITP logistics or student services at the CAA, Nora can be found skiing, sailing, or tending to her bees and dog, Bug, in Revelstoke. She is excited to deepen her understanding of the avalanche industry and work alongside the talented CAA team and industry professionals.



front lines

in this **section**

// DOUGLAS NOBLET

Grant Statham on **the History of the Conceptual Model of Avalanche Hazard**

Alex Cooper

In 2003, Grant Statham was hired by Parks Canada to implement the recommendations of the Backcountry Avalanche Risk Review that followed the 2003 Connaught Creek avalanche. His work led to the introduction of the Avalanche Terrain Exposure Scale, improvements to the public avalanche danger scale, and the development of the Conceptual Model of Avalanche Hazard.

I spoke to him about the evolution of the Conceptual Model into a tool that is an essential part of the forecasting workflow for avalanche professionals in North America and beyond. What follows is a transcript that was edited for clarity and length. To watch the full interview, visit *avalanchejournal.ca*.

Alex Cooper: Before getting into the Conceptual Model, I was wondering if you can just talk a little bit about what the forecasting process was like before it.

Grant Statham: That seems like a long time ago now. For the longest time, we did it a specific way. We generally were formed up around the snow stability system and we used a snow stability rating checklist for our assessments. This is what the CAA was teaching and all of InfoEx did it this way, too. In the back of OGRS, you'll see the snow stability rating system.

We did a lot of the same stuff we do today. We would look at avalanche observations, weather observations, snowpack, but we didn't have a specific workflow. Today, we follow a particular workflow, and it follows a lot of the processes from the Conceptual Model, but we didn't use to have a formalized workflow, especially for public forecasting. InfoEx was pretty structured, but the public forecasting process wasn't.

There was a process. You'd go through the weather, the avalanches, write the snowpack summary, and then you would land on a snow stability rating and apply that across your region. But there were some problems with the snow stability system because it was being misapplied.

Snow stability is defined today as a point-scale observation. It's something you can use within a 2 m^2 area and it doesn't include any sense of consequence. It has no avalanche size. It's just what the stability is assessed to be at a single point, but we were applying it across whole regions, so there were some gaps. It was very common to read in InfoEx: "Poor stability but low hazard," which meant the snow

THE ORIGINAL COMMITTEE THAT WORKED ON THE CONCEPTUAL MODEL OF AVALANCHE HAZARD AND NORTH AMERICAN PUBLIC AVALANCHE DANGER SCALE AT A MEETING IN CANMORE, ALTA., IN 2008. BACK ROW, FROM LEFT: KARL BIRKELAND, UNITED STATES FOREST SERVICE NATIONAL AVALANCHE CENTER; JOHN KELLY, CANADIAN AVALANCHE CENTRE, CHRIS STETHEM, CONSULTANT, GRANT STATHAM, PARKS CANADA, AND CLAIR ISRAELSON, CANADIAN AVALANCHE CENTRE. FRONT ROW, FROM LEFT: BRAD WHITE, PARKS CANADA, PASCAL HAEGELI, CONSULTANT, BRUCE TREMPER, UTAH AVALANCHE CENTER, SUSAN HAIRSINE, PROJECT ADMINISTRATOR, AND ETHAN GREEN, COLORADO AVALANCHE INFORMATION CENTER. MISSING IS BRUCE MCMAHON, PARKS CANADA. // CAA ARCHIVES was unstable but there was no consequence to it. The public forecasts used the danger scale, which contained likelihood language but no sense of consequence and no process to determine what the danger rating was other than the same scale the public saw. We wanted to separate assessment and public communication.

Our objective was to try to pull all this together into a new system that was broader than stability. We wanted risk-based systems that included consequence. That was important. We wanted to get avalanche size involved in the assessment, and then bring everybody together to use a common framework.

How did that develop?

It really started in 2003. The Avalanche Risk Review, which I was not involved in preparing, the Number 1 recommendation out of 36 was to work with the CAA to revise the danger scale. I got hired to implement that report, but it was pretty clear to me this was a complicated project and it needed to be done across borders. You don't do that unilaterally.

I had two years to implement that report, so what we did is we developed a new system called the Backcountry Avalanche Advisory, and it was focused on communication. We had three levels of conditions, and we built those icons you see on the danger scale today.

Once that was done and the initial pressure was off to implement that report, I shifted to the danger scale. In talking with colleagues in the U.S., they wanted to do the same thing. Everybody recognized we needed to revise this thing. The danger scale had no avalanche size, so it didn't have any consequence. We wanted to separate the assessment and communication of avalanche danger. I started working on that in probably 2006.

How did the Conceptual Model flow out of that work on the danger scale?

It was never really a plan to do that. The new Canadian Avalanche Centre (CAC) formed an ad hoc committee. I was leading this committee and we pulled in some guys from the U.S. and started working. From my point of view, the first thing we needed to figure out if we're going to redo the danger scale was, what actually is avalanche danger?

Everybody had different definitions of what danger, hazard, and risk meant. I realized right away I didn’t know the proper definitions of risk and hazard, which is kind of crazy when you think I’d been forecasting for 15-years and a CAA instructor for the previous decade. Our group was initially all over the place on this, so we started there. Let's get on the same page with definitions and a risk-based framework.

Then I asked, “How do you determine avalanche danger? What's your process?” Again, everybody had different processes and there was no consistent method someone could describe. It was funny, because we would usually all land in the same place, but in terms of how to get there, there wasn't a single way we would follow.

Our objective became to first define the risk-based terminology and structure, then to build a workflow for avalanche hazard assessment, then revise the danger scale with a focus on public communication. It turned into a three-stage project (Fig. 1).

Project Objectives

1. Clarification of terminology and definitions including avalanche hazard, danger and risk.
2. Develop a conceptual model of avalanche hazard, using this to describe the inputs and process of evaluating avalanche hazard.
3. Revise the Avalanche Danger Scale so it is linked to the evaluation process, and is communicated effectively.

FIG. 1: THE THREE OBJECTIVES FOR THE PROJECT TO REVISE THE DANGER SCALE.

How did you develop the workflow for the Conceptual Model?

There were a few things going on at that time. First, in 2004, Roger Atkins published a paper called *An Avalanche Characterization Checklist for Backcountry Travel Decisions* (ISSW 2004). It seems normal now, but at the time it was unique and a very interesting way to talk about backcountry avalanche hazard in terms of different kinds of avalanches that would result from different conditions and lead us to the different terrain choices. It really resonated—I recommend anybody read Roger’s paper. Our framework initially used a concept called “Avalanche Character,” which later became the “Avalanche Problem Type”.

At the same time, I got pulled deep into a book by Steven Vick called *Degrees of Belief: Subjective Probability and Engineering Judgement*. That book changed my life as it exposed me to the world of risk and, in particular, subjective risk assessment. I learned about the large body of science behind subjectivity. It described the process of decomposition, so taking a complicated problem and decomposing it into its basic components. We used that for avalanche danger. We started from the top with avalanche danger, and then we reverse-engineered it and broke it down into pieces, defined each piece, and then reassembled them into a risk-based framework that became the CMAH (Fig. 2).

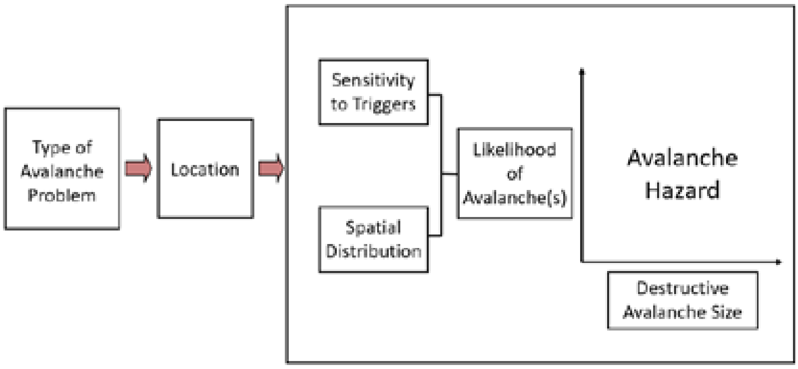


FIG. 2: THE AVALANCHE HAZARD EVALUATION WORKFLOW AS PRESENTED IN THE CMAH.

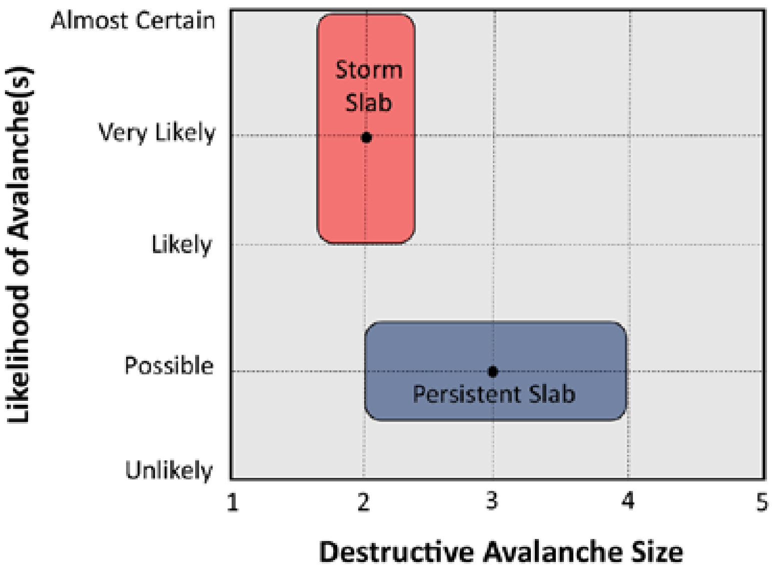


FIG. 3: THE SAMPLE AVALANCHE HAZARD MATRIX SHOWN IN STATHAM ET AL (2018).

We did that initially as this ad hoc committee. We started in 2005, but by 2007 it was pretty clear this was more complicated and we needed some funding. The CAC was applying for a SAR NIF project called Avalanche Decision-Making Framework for Amateur Recreation. One of pieces was to revise the danger scale; we got funding for several years and that allowed us to take it forward.

This project emerged from developing the (public) danger scale, but the Conceptual Model turned into something that could be used by all sectors of the industry. How did that come about?

You're right. We were focused on public danger originally, but as we worked on avalanche hazard, the results seemed to apply to our forecasting more broadly than just the danger scale. As it gained some traction, we did some testing using a website Pascal Haegeli made, and we tested it with different groups of people in the industry. The workflow—the avalanche character, the components of hazard assessment—really resonated.

The CAA saw it as an excellent tool for teaching and it became incorporated in the CAA training programs early on. This CMAH framework and risk theory in general became embedded in the development of the Level 3 course.

InfoEx was being rebuilt at that time as well. InfoEx went from being a report that was mostly data columns and paragraphs into a more structured method, and that structure followed the CMAH. Software development for avalanche forecasting was new then, and if you're a software developer and I handed you this model, you could program this into a computer. It caught on pretty fast.

We talked a bit about avalanche problems, but then size and likelihood are the two axes on the scale for hazard. It seems obvious now, but was it obvious at the time those are the two main factors for determining hazard?

No, it wasn't obvious. That goes back to the beginning, when we weren't all on the same page about what avalanche hazard was and what avalanche risk was. We didn't have clean definitions of either, and we weren't working off what I would today call a risk-based system.

If you look at that matrix with likelihood on one axis and size on the other (Fig. 3), that's basically probability and consequence. That's a risk-based chart. The whole thing that underpins everything we did was the shift to risk-based thinking and how we first assess avalanche hazard, then incorporate exposure and vulnerability. Hazard assessment lands on avalanche hazard, but the actual decisions we make are based on risk and that must include the exposure and vulnerability of whatever element is at risk.

Avalanche hazard is Mother Nature. Then expose different things to that hazard: stick a highway in there, go heli-skiing, open a ski area—that's exposure, and now something is vulnerable. It seems obvious and simple to me now, I guess, but at the time it didn't.

I remember I drove my colleagues crazy during the first two years of this project because people thought I was wasting time working on those definitions. If you look at the various papers we published—we published three, one for each component—I'm the only author of the first one on definitions (ISSW 2008) and that's because I was driving everybody crazy with my focus on definitions. I think they were going to jump ship, so I had to get that done fast so we could move on to the stuff everybody else wanted to work on. But it turns out, that was important.

How did you pull people around into accepting those definitions?

Slowly but surely, with a ton of meetings and presentations and a lot of listening. You and I are talking about something that took a decade to get through. This is the common way risk is defined and managed in other industries, but at that point, avalanche forecasting wasn't risk-based. What was risk-based was the engineering side of avalanche work. The consultants and the engineers, they used risk-based systems.

Alan Jones helped me a lot because he is an engineer and was familiar with these concepts and used them in his day-to-day engineering work. I was trying to take those same concepts and plug them into backcountry avalanche risk and public avalanche forecasting. It was an awkward fit at first, but over time, as it became clearer, it made a lot of sense because it connected with how we actually do our work. Plus it mimics how risk is defined and managed in most other industries.

How did it evolve into becoming something that's embedded in everything that's done for avalanche forecasting today?

Well, it's kind of funny. That was never the plan, right? I did get the sense as it was coming together, "This is pretty good, I think people are going to like it." I didn't expect it would turn into what it is today. InfoEx has a lot to do with that. That embedded it in Canada. For sure the publication of our paper embedded it outside of just Canada.

It's not perfect, that's for sure, but it's a conceptual idea of how to look at avalanche danger and risk, and how to fit it all together. I would say the acceptance of it was quick, but at the same time it was a slow process over years. We're talking about almost 20 years ago when we started working on it. It wasn't immediate and it was a lot of work to bring the industry onboard.

In the end, I've always really believed the systems that are good are going to—they *need* to—stand on their own feet. You have to build it, and then you have to put it out there and watch what happens in the real world. You have to listen closely to the feedback and incorporate it. If it's good, people are going to use it. If it's not good, they aren't going to use it. That was always my rationale. Let's build something, put it out there, and watch what happens to it. And this thing got picked up.

I find it interesting the Conceptual Model started out of a project to revise the danger scale, but in the end, there is no direct link from the Conceptual Model hazard chart to the danger scale. Can you talk about why you didn't include a link to the danger scale?

Good question. To be honest, I would say my Number 1 goal was to build an assessment method that linked to a danger rating. We were originally inspired by the Bavarian Matrix (see page 33). It's how the Europeans landed on their danger ratings. The first one I ever saw was in German, and they didn't have an English version. Alan Jones got his mother to translate it for us.

That was our goal. In the end, we could have drawn the danger ratings into that hazard chart. In fact, we did do that (Fig. 4), but we decided to not just randomly draw lines and colours in there. We wanted to do it from data, and this is what didn't work out in the end.

The idea was, let's collect data for a number of years as people use this thing, then let's look for patterns, and we'll be able to make the link to the danger rating. This was work that happened through Pascal Haegeli at Simon Fraser and his students. They did a bunch of data analysis to see if they could link the assessments to the danger ratings. That was our goal, but it didn't work.

In retrospect, I do wish we had linked it. I think we should have drawn it in there. I can tell you roughly where the lines

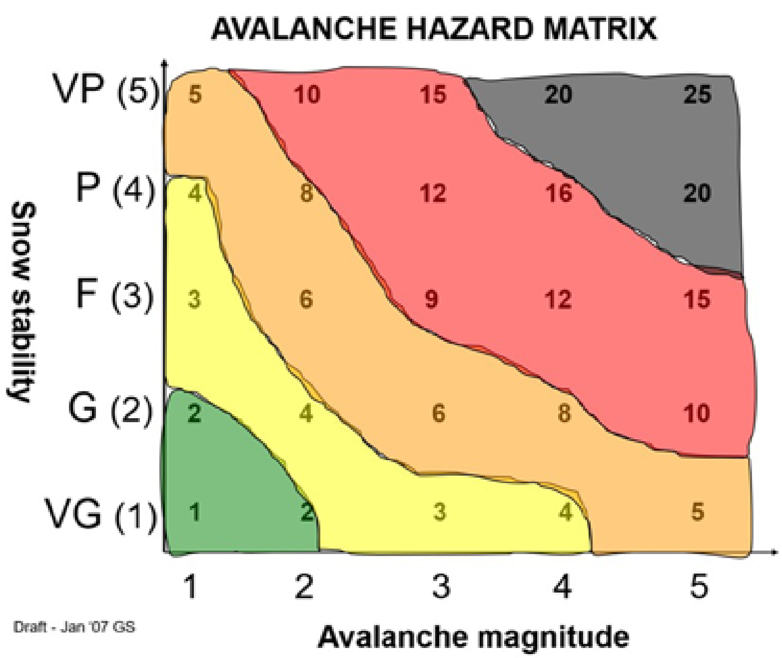


FIG. 4: AN EARLY DRAFT OF THE AVALANCHE HAZARD MATRIX, WITH DANGER RATINGS COLOURED IN.

are: lower left corner is low danger; upper right corner is extreme danger, and then there's some mix in between. It didn't work out that way, unfortunately. It seems like low-hanging fruit to me.

What was the problem with collecting that data?
Well, we're humans, not machines. I think this is maybe the biggest learning I've had out of the whole thing. Everything we read was if you develop a consistent workflow and a structured method that makes people more consistent, we will all consistently follow the same way and land in the same place. In the beginning, we didn't have that workflow. You would discuss the snowpack structure and avalanche observations, and then you would pick a stability rating—you'd make one choice.

With the CMAH, there was now five to 10 choices to make. You've got to pick the avalanche problem type and the sensitivity, then you pick the spatial distribution, the likelihood and the size, then you choose the danger level. What that did in addition to bringing us all onto the same page, is it revealed our inconsistencies and individual tendencies as we debated each component. This is human nature and the CMAH was our tool that revealed it.

When Pascal and his students tried to put the data together and see what patterns led to what danger ratings, the data was quite scattered. There weren't discernable patterns that could be linked to a danger rating.

How about yourself? You use the conceptual model when you forecast. How do you feel you when you sit down and use it? What are the things you like about it and what are the things that you wish you could do differently?
I'm obviously a little bit biased, but it's got us all to understand the structure of avalanche hazard. I've been watching how similar work is evolving in Europe and they use a different method, but it's the same thing. They're landing on a likelihood and size framework to get to avalanche danger. We're all going in the right direction.

Probably the thing that drives me the craziest is meetings where we're talking endlessly about the location of a Size 1 wind slab. Is it a wind slab? Is it a storm slab? Is it even really a problem? I understand these are real questions, but sometimes I think we get caught up in stuff that doesn't really matter. We seem to get bogged down easily in details that often don't matter.

Sometimes people forget it's a conceptual model. It's not a physical model and it's not a statistical model. It's just a way of thinking about avalanche danger. One avalanche problem is going to overlap another, and there's just not a clean line drawn down the middle. I think that's hard for some people who are looking for black and white. This thing's full of uncertainty, just like avalanches.

Of course, there's little things I'd love to change. Overall, my biggest thing I wish we could do differently is accept the fact it's conceptual and not get hung up on what seem to be details that might not be as relevant to what we're doing that day.

You pointed out in your published paper that clear definitions on avalanche problems was something that needs to be determined, or when to transition from one problem to another. There's definitely quite a bit of research on that. Another thing that's come up is the clear definition of what 'possible' means, and what 'likely' means—defining those things.

Do you ever wish there was clear definitions on those, or were you happy we need to study this more before we can actually specifically define all the terms used?
I wish we had better definitions for many parts of the CMAH, or I wish it could be more cut and dried. But like I say, it's conceptual. I knew it was not going to be perfect even when we made it. This was just a step. If we can establish the basic framework of avalanche forecasting, then in the future, people will make it better. There will be more research, people will tighten this model up, it will evolve. I really had no sense this was the end. It is actually just another step along the way, and it's going to get better.

In Europe, they have, what, five avalanche problems?
Correct. The European avalanche problems were developed for public warnings and ours were not. We did eventually want the danger scale to be the public product, but we were building something for forecasters to assess the hazard, so it was intended to be technical and as precise as we could make it.

Likelihood's tough, too. Likelihood, as it is now, I consider it to be too top heavy. There's too much likely, very likely, certain, almost certain. I wish we could readjust that one a little bit. I mean, the whole thing could use some work. There are always little things to fix up here and there.

If there is a CMAH 2.0, what would be the things you would want to see in it?
I would want to improve the likelihood assessment; I think it's a Holy Grail, but perhaps elusive. I've been working on that with Scott (and Bruce Jamieson) for the last bunch of years. But likelihood is a really complicated problem and I'm not sure we're ever going to find a good solution for it inside the Conceptual Model. The move to put numerical values of probability on our hazard assessments is really hard because of scale issues and lack of good data. With every proposal on this, I find myself wondering how I could ever make that assessment? Numbers seem great on the surface, but you need to ask yourself how you'll make the determination, and based on what? It has to work and be practical.

I'm watching some work in Europe right now, which I think is really going down the right road in terms of assessing likelihood across regions, which will ultimately have to come from snowpack modeling.

There's work to do on the avalanche problems. I think we could have sub-categories for public forecasting so we don't end up in this deep persistent/persistent dilemma that seems to be common. Persistent slab as a single category is much easier for the public to grasp.

I've got a long list of little things, nothing major though. I don't know if I'm going to step into a Conceptual Model V2. It might be time to let somebody else do that, but I think it's a really good question. I mean, these things have to evolve. Because I was the lead author, I often get asked, "Are you going to be updating it?" The answer at this point is, "No." Not because I don't think it needs it, but because I haven't had the time and I'm not sure I'm the best one to lead a revision. I've had my say already, but I would like to contribute my experience so the same mistakes aren't repeated.

I was really happy to see the inclusion of avalanche problems in OGRS this year. In the absence of this model living somewhere, it's hard to update it unless you write a new paper. You could write a new paper and embed it into CAA training, but you need some pretty broad consensus to do that. Who's going to do an update and who will manage it? I don't know who would update it and where it would live. It needs it, but I don't really know the structure of how to achieve this.

Those are my questions. Is there anything you think we missed talking about?

I was going to tell you the story about 2007. One of the questions you asked me before was did we get any pushback? There was lots. That's part of it. If you can't stand the pushback and defend your work with good logic and evidence, then it doesn't deserve to stand on its own.

In 2007, Clair Israelson convened this meeting he called the Senators Meeting. He gave me the floor for a whole day to present this model. It was totally intimidating. I was 38, everybody else is 50–60, my mentors. There I am, describing this completely different way of doing things. I remember at the end, the Chair of the CAA Technical committee tried to put people at ease saying, "Don't worry, we're not going to do this."

I was pretty choked. I had just spent all day working through concepts and new ideas with people. It was just one of those things that at the time, it was such a different way of looking at things and people were nervous. He shook his head at me in disbelief after the meeting and said, "I can't believe you're doing this, really trying to change everything." We spoke later and he apologized for the shutdown.

It's hard to push new stuff through. You have to be able to back it up and you have to be prepared for people to roar at you. I had to learn to write science papers, for crying out loud. I'm a mountain guide, that's not my background, but I had to learn to do it to push ideas through. Pushback is part of it and defending your work and making it stand on its own is pretty important.

Obviously you did a good job of that. Here we are today talking about it years later.

No kidding. Crazy.

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Public Avalanche Danger Scale

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CMAH 2.0: Adding Hazard Ratings to the Conceptual Model

Scott Thumlert

INTRODUCTION

Assessing, rating, and forecasting the physical hazard posed by snow avalanches is fundamental to daily work for avalanche professionals. Avalanche risk mitigation strategies (e.g. explosive control, communicating danger level and terrain advice to public, closing terrain at a resort, selecting terrain when guiding) are implemented largely based on the assessment of the physical avalanche hazard. That is, the physical hazard posed by avalanches is assessed first, and mitigation strategies typically follow.

There are currently no established Canadian hazard rating systems that include guidelines for how ratings are to be applied and that effectively describe physical avalanche hazard independent of elements at risk. The widely used Conceptual Model of Avalanche Hazard (CMAH) details a framework for data analysis and collection, yet deliberately does not establish a deterministic link from the assessment to operational hazard ratings. According to Statham et al. (2018), *"Instead, the CMAH's model provides the platform for a detailed assessment, and a framework for data analysis and collection. This was done deliberately to support future empirical analyses (e.g., Haegeli et al. 2012; Shandro et al. 2016) in establishing more robust links between assessment methods and any operational rating systems."*

Establishing the link from the assessment framework detailed in the CMAH to operational hazard ratings suitable for professionals is the next logical step.

This article further argues the current professional avalanche hazard rating scale used in InfoEx (Fig. 1) is too simplistic to capture the core factors professionals must consider when assessing and rating avalanche hazard. This is likely because it is based on the public avalanche danger scale, which has the primary purpose of communicating avalanche hazard to the recreating public. That is, the element at risk is considered and incorporated into the scale. For example, consider the InfoEx hazard rating scale in Figure 1—it is likely difficult to assign a hazard rating for the following scenarios:

1. Storm slab avalanches–likely (naturals)/very likely (artificially triggered) to Size 1.5, expected to exist on all aspects and elevation bands.
2. Deep slab avalanches–unlikely to Size 4, thin snowpack areas.

Consider scenario one: the likelihood description indicates the hazard would be high, whereas the size description indicates considerable. When considering scenario two, the likelihood description indicates the hazard should be high, whereas the likelihood description suggests the hazard would be low.

This article provides background on avalanche hazard assessment, details the four core factors contributing to the physical hazard posed by avalanches, and outlines a pathway towards the development of the required hazard assessment and rating system.

BACKGROUND

Avalanche professionals assess avalanche hazard for terrain over varying spatial scales:

- Mountain range or region (e.g. public forecast regions, > 100 km^2).

Avalanche Hazard Rating Scale

Hazard Level	Likelihood of Triggering	Size and Distribution
5	Natural and artificially triggered avalanches almost certain.	> Size 3 avalanches are widespread.
4	Natural avalanches likely; artificially triggered avalanches very likely.	Size 2-3 avalanches are widespread; or > size 3 avalanches in specific areas.
3	Natural avalanches possible; artificially triggered avalanches likely.	< Size 2 avalanches are widespread; or size 2-3 avalanches in specific areas; or > size 3 avalanches in isolated areas.
2	Natural avalanches unlikely; artificially triggered avalanches possible.	< Size 2 avalanches in specific areas; or size 2-3 avalanches in isolated areas.
1	Natural and artificially triggered avalanches unlikely.	< Size 2 avalanches in isolated areas or extreme terrain.

FIG. 1: THE HAZARD RATING SCALE USED BY CANADIAN AVALANCHE PROFESSIONALS IN THE INFOEX.

- Mountain or drainage (e.g. ski resort, group of paths affecting transportation corridor, guiding tenure, ~ 10 km^2).
- Path or terrain feature (e.g. specific avalanche start zone, < 1 km^2).

The variability of the snowpack across larger spatial scales means the physical hazard over terrain also varies. That is, there may be areas of low or no hazard and areas of elevated hazard within the assessment area or forecast region. Avalanche hazard assessment across the terrain in the forecast area must account for this variation.

Modern avalanche hazard assessment systems (e.g. Statham et al., 2018; McClung and Schaerer, 2022) incorporate the concept of avalanche problem types (e.g. dry loose, wet slab, persistent slab) based on Atkins' (2004) descriptions of the character of expected avalanches. Incorporating the type of avalanche expected provides valuable information about the behaviour of these avalanches, their location in the terrain, and the time this type of avalanche can be expected to exist.

Snowpack assessment can contain a varying number of avalanche problems. In general, early-season snowpacks have fewer expected problems due to the lack of buried persistent weak layers. As the season progresses, snowpacks often get more complex, with multiple buried weak layers, cornice growth, and surface snow instabilities potentially present. An effective assessment of avalanche hazard must include an analysis of how the complexity of multiple avalanche problem types contributes to the overall hazard assessment.

Most traditional and recent avalanche hazard assessment literature (e.g. Meister, 1994; Canadian Avalanche Association, 2016; Statham et al., 2018; McClung and Schaerer, 2022) describes avalanche hazard across terrain as a function of the expected size and likelihood of avalanches. Figure 3 on page 24 shows an example of avalanche hazard with uncertainty illustrated by the extent of the ellipses for two avalanche problems.

Avalanche size is well described with the Canadian destructive potential scale (McClung and Schaerer, 2022; CAA, 2024), and in general, larger expected avalanches equate to increased hazard.

Assessing the likelihood of avalanches is complex and involves subjective probability assessments (process described well by Vick, 2002) derived from many data sources like recent avalanche activity, snowpack structure, and weather inputs. Subjective probability assessments are now widely communicated with an ordinal scale of verbal probability descriptors: unlikely, possible, likely, very likely, and almost certain (Statham et al., 2018). Higher likelihood assessments should mean more avalanches are expected across terrain.

In general, increasing expected avalanche size or likelihood equates to higher avalanche hazard. However, assessing avalanche hazard across terrain as only a function of likelihood and size is simplistic and does not include the variation of hazard across the forecast region, nor does it allow for the assessment of the complexity of the snowpack by assembling multiple avalanche problems.

PHYSICAL AVALANCHE HAZARD

What components effectively describe the physical hazard due to snow avalanches across terrain? First it is important to define the physical hazard across terrain—a source of potential harm, damage, or loss. Physical hazard can be described as the potential hazard posed by the current or future state of the snowpack. While our knowledge about the state of the snowpack always involves a degree of uncertainty—and more uncertainty can increase risk—the snowpack and the resulting physical hazard does not change based on our knowledge of it. That is to say we can, and in many cases should, describe the potential hazard due to the current snowpack before considering the elements at risk.

Using the concepts presented above, the following four components are proposed to describe the physical avalanche hazard across terrain: likelihood of avalanches, magnitude, amount of terrain, and complexity of the snowpack.

1. **Likelihood of avalanches:** the release probability, historically called snow stability. Likelihood of avalanches is basically the chance of avalanche activity in the forecast area within the forecast time period, or the chance that a specific path or start zone will release during the time period, regardless of avalanche size. Higher likelihood assessments should indicate increased avalanche activity is expected. An effective system used to communicate a forecaster's likelihood assessment should use clear definitions to promote effective communication (Fischer and Jungermann, 1996), increase forecasting accuracy (e.g. Rapoport et al., 1990), and improve decision-making (Friedman et al., 2018). The likelihood definition and system should also be largely independent of the spatial scale being assessed. That is, the system should work equally well when assessing single paths to larger regional scales.

   The following definition is proposed: *Likelihood of avalanches is the chance of the start zones where the avalanche problem is expected to exist releasing within the forecast time period (Table 1)*.
2. **Magnitude:** the estimated size (i.e. destructive potential) of the expected avalanches as defined by the Canadian avalanche size scale (CAA, 2024). Magnitude is a core component of avalanche hazard. The size definitions are widely used and accepted across industry.

3 **Amount of terrain:** basically, the proportion or amount of terrain across the forecast area where avalanche problems are expected to exist. More terrain in the forecast region containing avalanche problems equates to higher hazard. For example, a day when the assessed avalanche problem and corresponding hazard is expected to exist only on southerly aspects in the forecast region (e.g. persistent slabs likely to Size 2.5) presents less overall physical hazard than another day when the assessed avalanche problem exists on all aspects. Put another way, if the assessment of avalanche problems results in more terrain features or start zones across the forecast region having a chance of avalanches, then it follows there will be more physical avalanche hazard across the forecast region.

4) **Complexity of the snowpack:** this component of avalanche hazard relates to the number and type of avalanche problems expected to exist in a given snowpack structure, and how forecasters assemble them into an overall hazard rating. Simpler snowpacks that are less deep, contain less weaknesses, and are more homogeneous across terrain are

TABLE 1: PROPOSED SCALE DESCRIBING THE LIKELIHOOD OF AVALANCHES.

VERBAL PROBABILITY TERMS	NUMERICAL PROBABILITY	FREQUENCY DESCRIPTION (OR RATES OF RELEASE) *
VERY LIKELY, ALMOST CERTAIN, HIGHLY PROBABLE, ALMOST CERTAINLY	> 75%	More than 75 out of every **100 paths or start zones** in the region release.
LIKELY, PROBABLE, GOOD CHANCE, QUITE PROBABLE	50 - 75%	50 to 75 out of every **100 paths or start zones** in the region release.
FAIR CHANCE, EVEN CHANCE, UNCERTAIN, NOT CERTAIN, POSSIBLE	5 - 50%	5 to 50 out of every **100 paths or start zones** in the region release.
UNLIKELY, NOT LIKELY, PROBABLY NOT, IMPROBABLE, DOUBTFUL, QUITE UNLIKELY	0.1 - .5%	1 to 50 out of every **1000 paths or start zones** in the region release.
HIGHLY UNLIKELY, REMOTE CHANCE, ALMOST NO CHANCE, NEARLY IMPOSSIBLE, HIGHLY IMPROBABLE	< 0.1%	**At most** 1 out of every **1000 paths or start zones** in the region release.

*FREQUENCY DESCRIPTIONS ARE NOT VERY USEFUL WHEN FORECASTING FOR SINGLE PATH OR AREA WITH FEW PATHS - USE NUMERICAL PROBABILITY RANGES OR VERBAL PROBABILITY TERMS. WHEN ASSESSING A SINGLE PATH OR AN AREA WITH A FEW PATHS, FORECASTERS MAY FIND IT USEFUL TO REPLACE THE SPATIAL REFERENCE CLASS IN THE FREQUENCY DESCRIPTION WITH A TEMPORAL ONE. THE FORECASTER WOULD THEN ASSESS HOW MANY DAYS WITH SIMILAR CONDITIONS WOULD RELEASE AVALANCHES. FOR EXAMPLE, THE FORECASTER MAY EXPECT THAT THE START ZONE WOULD RELEASE ON ABOUT ONE OUT OF 100 DAYS WITH SIMILAR CONDITIONS.

less hazardous than deeper snowpacks with multiple weak layers that vary in the terrain. For example, a snowpack assessed as only having a storm slab problem (e.g. likely to Size 2) will behave more predictably (less complexity) and thus is less hazardous compared to a similar snowpack with additional deeper weaknesses such as a deep slab problem (e.g. possible to Size 3.5). It is important to note that this type of uncertainty with the snowpack structure is different than the uncertainty that a forecaster may have due to the lack of data or observations, which may result in lower confidence in hazard ratings.

A complete and thorough assessment of avalanche hazard across mountain terrain requires all four elements to be included. Rating and communicating the hazard assessment is the natural next step that avalanche professionals must complete.

OPERATIONAL AVALANCHE HAZARD RATING SYSTEMS

Hazard rating systems have proven to be an effective method for communicating the output of a forecaster's hazard assessment (e.g. Statham et al. 2010a; SLF, 2015; EAWS 2016a; Avalanche Canada, 2024). While operational decision-making may rely more heavily on detailed avalanche problem descriptions, these descriptions are often too detailed for efficient communication amongst professionals. Ordinal five-level systems complete with descriptions of each level are common, although many industrial applications employ simpler three-level systems.

For valid reasons, different operations tailor their hazard rating systems to their operational needs; consequently, rating systems often include risk management strategies. For example, the widely adopted North American Public Avalanche Danger Scale (NAPADS) shown in Figure 2 includes "Travel Advice" as its primary purpose is public risk communication (Statham et al., 2010). NAPADS was designed specifically for the element at risk (public backcountry recreationalists), thus its description of the physical avalanche hazard is specifically tailored for communicating with public recreationists. For example, there is no indication of the complexity of the snowpack and how it is incorporated into the hazard rating.

REQUIRED SOLUTION

As mentioned, there are currently no established hazard rating systems that include guidelines for how ratings are to be applied and that effectively describe physical avalanche hazard independent of elements at risk. The Conceptual Model proposed by Statham et al., (2018) deliberately does not include a hazard rating scale, nor does it establish a deterministic link or process to arrive at a hazard rating. That is, the final step in assembling avalanche problem assessments into an overall avalanche hazard rating remains to be completed and is the next logical step.

A rating system effective for use by all avalanche professionals would be designed specifically to describe physical avalanche hazard across terrain and would be independent of any element at risk. Definitions for each hazard level would enable clear and effective communication of an avalanche professional's assessment of avalanche hazard and would support risk mitigation strategies.

The definitions and the process employed to assign the ratings should be applied independent of the spatial scale of the forecast, include analysis of the four components of avalanche hazard described above, and would be built from clear meaningful language. These hazard definitions and associated guidance would likely reduce variation between practitioners' evaluations, provide a learning resource for new professionals, and improve consistency in communication across the profession.

The rating system would be used widely to describe the raw physical avalanche hazard prior to consideration of operation or element at risk, and therefore, would be useful for the InfoEx community, taught in the Industry Training Program, and be integral to daily workflows for the majority of avalanche professionals.

North American Public Avalanche Danger Scale

Avalanche danger is determined by the likelihood, size, and distribution of avalanches.
Safe backcountry travel requires training and experience. You control your risk by choosing when, where, and how you travel.

Danger Level	Travel Advice	Likelihood	Size and Distribution
5 - Extreme	**Extraordinarily dangerous avalanche conditions.** Avoid all avalanche terrain.	Natural and human-triggered avalanches certain.	Very large avalanches in many areas.
4 - High	**Very dangerous avalanche conditions.** Travel in avalanche terrain not recommended.	Natural avalanches likely; human-triggered avalanches very likely.	Large avalanches in many areas; or very large avalanches in specific areas.
3 - Considerable	**Dangerous avalanche conditions.** Careful snowpack evaluation, cautious route-finding, and conservative decision-making essential.	Natural avalanches possible; human-triggered avalanches likely.	Small avalanches in many areas; or large avalanches in specific areas; or very large avalanches in isolated areas.
2 - Moderate	**Heightened avalanche conditions on specific terrain features.** Evaluate snow and terrain carefully; identify features of concern.	Natural avalanches unlikely; human-triggered avalanches possible.	Small avalanches in specific areas; or large avalanches in isolated areas.
1 - Low	**Generally safe avalanche conditions.** Watch for unstable snow on isolated terrain features.	Natural and human-triggered avalanches unlikely.	Small avalanches in isolated areas or extreme terrain.

FIG. 2: THE NORTH AMERICAN PUBLIC AVALANCHE DANGER SCALE (AVALANCHE CANADA, 2024).

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Wake Up, Neo, The Matrix Has You
An Overview of the European Avalanche Warning Service Matrix

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THE CONCEPTUAL MODEL OF AVALANCHE HAZARD (CMAH) IS NOT (YET) A STANDARD FOR AVALANCHE PROFESSIONALS IN EUROPE; however, many European avalanche forecasters have been trained on it through professional courses or exchanges in North America, and many more are familiar with its principles and find them intuitive.

As an avalanche forecaster for the Norwegian Avalanche Warning Service (NAWS), I've had the privilege of seeing how various frameworks and concepts are applied in public avalanche forecasting. Starting in 2010 and officially launched in 2013, NAWS is a relatively young service now entering its teenage years. Setting up an avalanche warning service from scratch was no small task, especially when it involved training many forecasters and observers in a short period of time.

In our early days, we were fortunate to visit established forecasting operations in Europe and North America. We learned from the giants of the field, including the Swiss and French services, but also engaged with smaller ones to understand their perspectives and approaches. Many of them have contributed to and forged the traditions and standards of the European Avalanche Warning Service (EAWS), a coalition of national public warning services that has developed standards and best practices since 1983. Central to these standards were the European Avalanche Danger Scale (EADS), the information pyramid, and—at that time—the Bavarian Matrix (BM).

Our journey also brought us to Banff and Revelstoke, where we met key figures behind the CMAH, including Grant Statham and Karl Klassen. The CMAH immediately resonated with us—it brought structure to the complex process of assessing avalanche danger (or hazard, though I'll stick to "danger" since it feels more familiar). While the CMAH wasn't officially part of European standards, it felt closely aligned with practices we'd seen in Europe, even if those weren't always written down explicitly.

A NEW MATRIX

At NAWS, we began integrating the tools available to us: the CMAH as a conceptual framework, the EADS as both a guideline for determining the danger level and a communication tool for the public, and the Bavarian Matrix to bridge the gap between these two.

The CMAH needs little introduction to readers of this issue of *The Avalanche Journal*. It provides a systematic framework for avalanche hazard assessment by addressing avalanche problems, their location, likelihood, and size. It has a broad scope and was designed to serve various avalanche operations from backcountry guiding to road safety to regional public forecasting.

In contrast, the EADS and Bavarian Matrix were specifically tailored for regional public avalanche warnings. The EADS was introduced in 1993 to standardize the communication of avalanche danger across Europe and simplify cross-border travel for users. It has significantly impacted forecasting processes by providing a common standard, but despite its widespread adoption, the terminology within the scale was never clearly defined, nor were unified guidelines established. As a result, individual services developed their own interpretations over time, leading to divergence and inconsistencies. In North America, the EADS was adopted in 1994 but underwent significant revision, resulting in the North American Public Avalanche Danger Scale (NAPADS) and triggering the development of the CMAH.

To harmonize the use of danger levels among European avalanche forecasters, the EAWS adopted the Bavarian Matrix in 2005 (Fig. 1). Designed by Bernd Zenke at the Bavarian Avalanche Warning Service in Germany, the BM aimed to disentangle the factors describing avalanche danger in the scale. It provided guidance where the EADS lacked specificity, but it inherited the EADS' limitations, such as vague definitions of snowpack stability, spatial distribution, and probability terms.

Around 2015, as the EAWS strengthened its collaboration through a memorandum of understanding, it became clear that refining and improving shared standards like the EADS and the BM was a collective priority. This effort reflected the growing recognition that consistency and collaboration across borders were essential for the future of regional avalanche forecasting. The EAWS General Assembly, held every two years, has served as the venue for approving new public avalanche warning standards or updating existing ones.

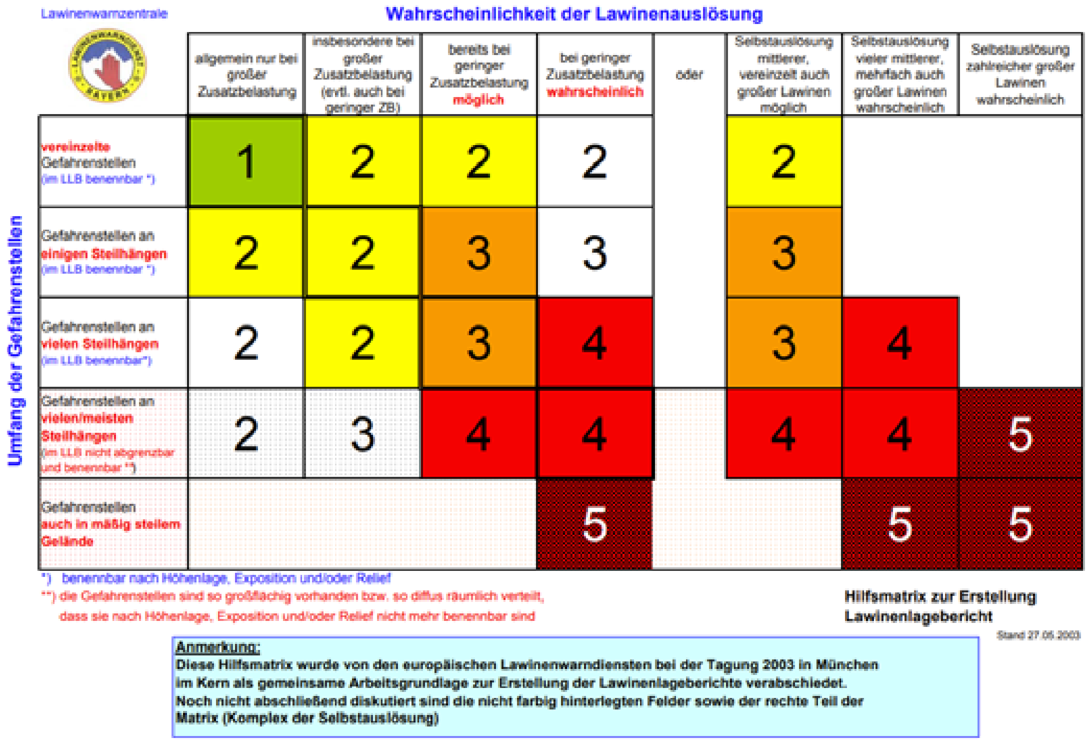


FIG. 1: THE ORIGINAL BAVARIAN MATRIX IN GERMAN, AS INTRODUCED IN 2003 AND ADOPTED AS AN EAWS STANDARD IN 2005. ITS VERTICAL AXIS REPRESENTS THE DISTRIBUTION OF HAZARDOUS SITES, WHILE THE HORIZONTAL AXIS INDICATES THE LIKELIHOOD OF TRIGGERING. THE MATRIX IS DIVIDED INTO TWO SECTIONS: THE LEFT-HAND SIDE ADDRESSES HUMAN-TRIGGERED AVALANCHES, AND THE RIGHT-HAND SIDE FOCUSES ON NATURAL AVALANCHES. AVALANCHE SIZE WAS EMBEDDED WITHIN THE LIKELIHOOD OF TRIGGERING, RATHER THAN BEING TREATED AS A SEPARATE DIMENSION.

THE EAWS MATRIX

I became part of the working group tasked with updating the Bavarian Matrix and defining its most central terms. We presented ADAM (Avalanche Danger Assessment Matrix, Fig. 2) at the 2016 International Snow Science Workshop in Breckenridge, Colorado. ADAM was an attempt to merge the BM with CMAH principles, while tailoring the latter to the needs of regional avalanche forecasters. We also liked to believe it helped spread awareness of the CMAH in Europe and of the BM in North America.

After several iterations, we presented the updated version, now known as the EAWS Matrix (Fig. 3), at the 2022 EAWS General Assembly, where it was officially approved. The latest update provides a comprehensive tool for assessing avalanche danger ratings by incorporating three factors: snowpack stability (displayed as panels in Figure 3), frequency (y-axes of the panels), and avalanche size (x-axes of the panels).

I am aware these terms may sound unfamiliar or awkward to many avalanche professionals in North America. To bridge this gap, I've included related CMAH terminology alongside the EAWS Matrix in Figure 3. For the following description however, I'll stick to the European terms—feel free to mentally translate them to their CMAH equivalents as you read on.

Each panel in the matrix represents a specific class of snowpack stability (or sensitivity to triggers). The y-axis of each panel reflects the frequency this stability class is found in avalanche terrain across the forecast region. It is combined with the stability assessment to provide a measure of the likelihood of triggering, while avoiding ambiguous terms such as "possible" or "likely." Destructive avalanche size is

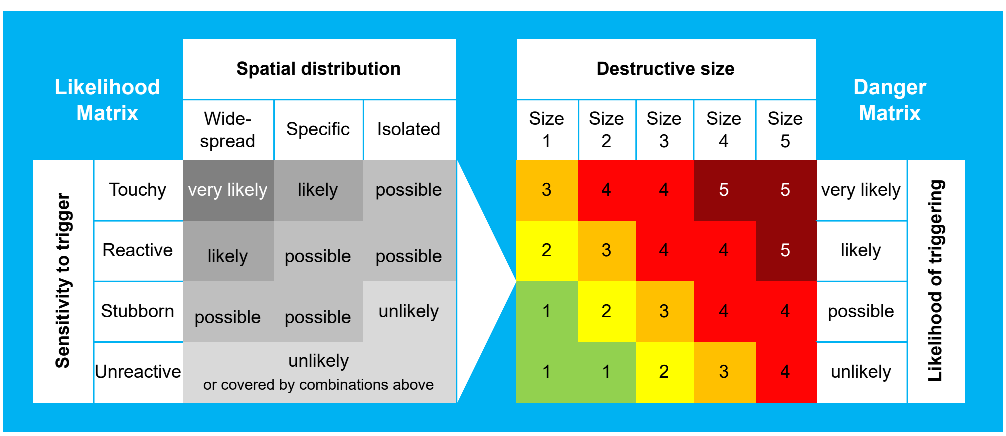


FIG. 2: THE AVALANCHE DANGER ASSESSMENT MATRIX (ADAM) AS PRESENTED AT THE 2016 ISSW IN BRECKENRIDGE, COLORADO THIS VERSION INCORPORATED THE TERMINOLOGY FROM THE CMAH. THE LIKELIHOOD OF TRIGGERING IS FIRST ASSESSED BY COMBINING SENSITIVITY TO TRIGGERS WITH SPATIAL DISTRIBUTION. THIS LIKELIHOOD IS THEN CARRIED OVER TO THE RIGHT-HAND SIDE, WHERE IT IS COMBINED WITH AVALANCHE SIZE TO SUGGEST THE APPROPRIATE AVALANCHE DANGER LEVEL. ADAM EVOLVED INTO THE EAWS MATRIX.

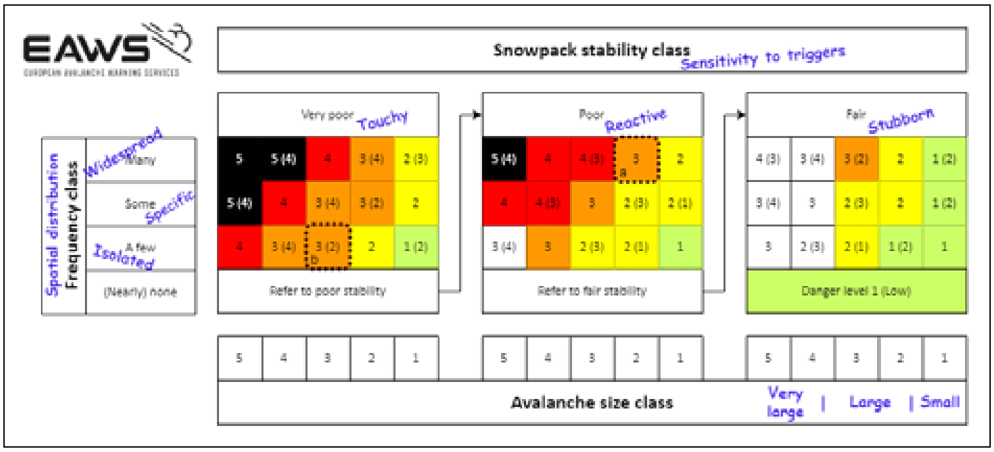


FIG. 3: THE EAWS MATRIX, WITH THE RELATED TERMS FROM THE CMAH INCLUDED FOR REFERENCE IN BLUE TEXT. WHILE NOT ALWAYS A DIRECT TRANSLATION, I HOPE IT AIDS IN UNDERSTANDING THE GENERAL CONCEPT. THE CELLS SURROUNDED BY A DOTTED LINE AND MARKED 'A' AND 'B' REFER TO AN EXAMPLE LATER IN THE TEXT.

depicted along the x-axis, making each panel in essence a CMAH hazard chart (Fig. 1) for the given stability class. To use the matrix, the avalanche forecaster determines the relevant avalanche problems and selects the cell(s) that best describe the current conditions in the region.

Let's take a simple example. Imagine a forecast region with a widespread layer of buried surface hoar, some 40-60 cm deep that remains reactive. There has been no recent snowfall, but some wind-transport. An avalanche forecaster might assess that skier-triggered avalanches are likely and that natural avalanches could occur in isolated locations. Using the EAWS Matrix, the forecaster can identify the relevant cells—like marking an avalanche problem in the CMAH hazard chart—and receive a suggestion for an adequate danger level.

For skier-triggered avalanches, the conditions might best align with the panel for "poor" stability in "many" locations, with avalanches reaching up to "Size 3" (cell marked as "a" in Figure 3). For natural avalanches, the conditions might correspond to "very poor" stability in "a few" locations, also with avalanches up to "Size 3" (cell marked as "b" in Figure 2). Both cells (a & b) suggest a danger level of "3-Considerable," so the forecaster is advised to issue this danger level. If the selected cells indicate different danger levels, the general rule is to assign the highest danger rating.

Studies show the lowest stability class is usually decisive in determining the danger level; therefore, the EAWS Matrix is set up from left to right, starting with the lowest stability class. If snowpack stability is considered good (or sensitivity is unreactive), the danger level is set to "1-Low."

Cells with a second danger level in parentheses are transitional. Since the classifications for stability, frequency, and avalanche size are relatively coarse, uncertainty in the data can make it challenging to assign precise values. If you, as a forecaster, arrive in a transitional cell, you must evaluate whether you lean towards larger or smaller avalanche size or frequency within their broad classes. Depending on this tendency, you are suggested to choose the higher or lower danger level suggested by the cell.

CONCLUSION

The EAWS Matrix was designed to initiate and guide discussions among avalanche forecasters when assessing regional danger levels and aims to enhance consistency and provide more detail than the coarse avalanche danger scale. However, it should not be worn as a straitjacket. Avalanche forecasting is an iterative process and is inherently uncertain, often relying on sparse data to tip the balance toward one conclusion or another. The matrix serves as a tool to structure this process, help forecasters navigate uncertainty, encourage consistent decision-making under similar conditions, and ultimately promote reliability in forecasts over time.

We are aware the EAWS Matrix is far from perfect. Even as I write this, new ideas and refinements are being circulated and debated within our working group and across European avalanche forecasting centres. Despite its imperfections, I believe the matrix represents a significant step forward in harmonizing avalanche danger level assessment.

The development of the EAWS Matrix reflects the influence of the CMAH's systematic approach to avalanche hazard assessment. While the CMAH provides a conceptual framework that supports diverse avalanche operations, the EAWS Matrix narrows this focus, tailoring it to the specific needs of regional avalanche forecasting. I hope this article has clarified the development, purpose, and role of the EAWS Matrix within the broader arsenal of frameworks and tools available to the regional avalanche forecaster. Its continued refinement will depend on collaboration, discussion, and the shared goal of improving avalanche safety from the international avalanche community.

For more details and recent developments, refer to the full paper by scanning the following QR code.

SCAN FOR FULL PAPER.

Avalanche Canada's use of **the Conceptual Model of Avalanche Hazard**

James Floyer, Program Director, Avalanche Canada

IT'S AN UNDERSTATEMENT to say the Conceptual Model of Avalanche Hazard changed the way forecasters assess avalanche danger at Avalanche Canada. We were an early adopter of the Conceptual Model and its preceding ideas. That makes sense—Avalanche Canada is all about regional forecasting. Analysing and communicating avalanche danger is at the core of what we do.

EARLY DAYS

Avalanche Canada was formed in 2004 in response to the tragic winter of 2002-03, when 29 people died in avalanches. 2004 was the same year Roger Atkins presented his seminal work, *An Avalanche Characterization Checklist for Backcountry Travel Decisions*. In Atkins' work, he identified seven categories of avalanche hazard: persistent instabilities, storm instabilities, wind slabs, surface instabilities, wet avalanches, glide avalanches, cornice failures, and ice falls. Within each category were more detailed avalanche types, such as "large slab avalanches in storm snow."

Using his method, someone making a hazard assessment would systematically go through every avalanche type in the checklist, and assign a likelihood rating (either unlikely, possible, or likely) to each. Once completed, the checklist presented a detailed picture of the avalanche hazard, with information about the type of avalanche, size (from the detailed descriptors), and likelihood.

Atkins' method provided a detailed and thorough yet readily understandable framework for assessing avalanche hazard, and Avalanche Canada (at that time known as the Canadian Avalanche Centre) readily adopted aspects of it. Bulletins from the mid- to late-2000s included the heading *Primary Concerns*, which listed the most important types of avalanches under the prevailing conditions. Initially, primary concerns were described in free-form text, but forecasters predominantly used terms taken from Atkins' categories.

FORMALIZATION

Over the next six years, work on conceptualizing avalanche hazard was refined by a group led by Grant Statham, which resulted in the presentation of *A Conceptual Model of Avalanche Hazard* at the 2010 International Snow Science Workshop in Squaw Valley, CA. Notably, two of Statham's co-authors worked for Avalanche Canada: Clair Israelson and John Kelly. Israelson and Kelly, and later Karl Klassen, promoted these ideas within our group and made changes that led to a more structured assessment of avalanche danger.

As the use of the Conceptual Model within the avalanche industry increased, avalanche problems, which are central to the model, became more prominent. Forecasts circa 2010 still used the *Primary Concerns* heading, but the categories were formalized, icons drawn up, and each considered in terms of its spatial and temporal distribution (Fig. 1). Behind the scenes, forecasters used an interactive assessment tool hosted on Pascal Haegeli's Avisualanche website (Fig. 2). This assessment tool contained all aspects of the newly created Conceptual Model, including the size-likelihood chart, with its characteristic ellipses, or blobs as we referred to them at the time.

In 2011, Parks Canada released AvalX, a software program for assessing regional avalanche hazard and authoring avalanche forecasts. AvalX was based entirely around the Conceptual Model, and the workflow took forecasters step-by-step through the process of assessing avalanche problems, their spatial distribution, size, likelihood, and relative contribution to the overall hazard. With the release of this software, avalanche problems were made visible to the

Purcells

	Thursday	Friday	Saturday
Alpine	4 High	3 Considerable	3 Considerable
At Treeline	4 High	3 Considerable	2 Moderate
Below Treeline	2 Moderate	2 Moderate	1 Low

Primary Concerns

Wind Slab

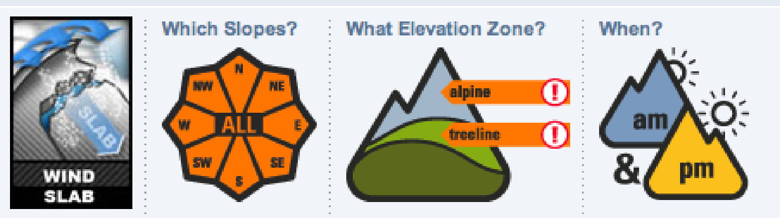
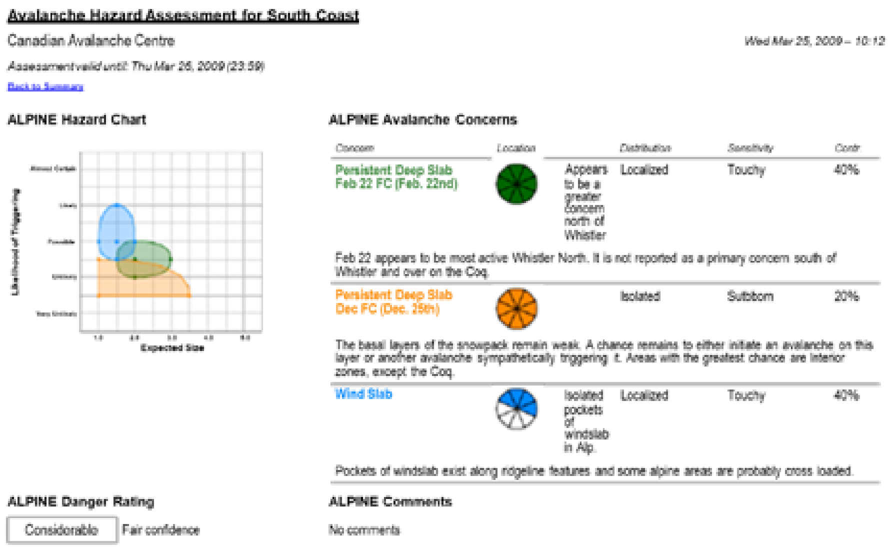


FIG. 1: PART OF THE AVALANCHE FORECAST FOR THE PURCELLS ISSUED APRIL 7, 2010.


Avalanche Hazard Assessment for South Coast

Canadian Avalanche Centre — *Wed Mar 25, 2009 – 10:12*

Assessment valid until: Thu Mar 26, 2009 (23:59)

Back to Summary

ALPINE Hazard Chart

ALPINE Avalanche Concerns

Concern	Location		Distribution	Sensitivity	Contr
Persistent Deep Slab Feb 22 FC (Feb. 22nd)		Appears to be a greater concern north of Whistler	Localized	Touchy	40%
Feb 22 appears to be most active Whistler North. It is not reported as a primary concern south of Whistler and over on the Coq.					
Persistent Deep Slab Dec FC (Dec. 25th)			Isolated	Stubborn	20%
The basal layers of the snowpack remain weak. A chance remains to either initiate an avalanche on this layer or another avalanche sympathetically triggering it. Areas with the greatest chance are interior zones, except the Coq.					
Wind Slab		Isolated pockets of windslab in Alp.	Localized	Touchy	40%
Pockets of windslab exist along ridgeline features and some alpine areas are probably cross loaded.					

ALPINE Danger Rating

Considerable — Fair confidence

ALPINE Comments

No comments

FIG. 2: PART OF THE AVALANCHE HAZARD ASSESSMENT FORM THAT WAS USED INTERNALLY BY AVALANCHE CANADA AND SOME OTHER ORGANIZATIONS FROM ABOUT 2009 TO 2011. THE FORM WAS HOSTED ON PASCAL HAEGELI'S AVISUALANCHE WEBSITE.

public on forecasts and icons were introduced to give users information about each problem's aspect, elevation, and size.

EDUCATION AND OUTREACH

With avalanche problems now occupying key real estate on public forecasts, and with widespread adoption of this concept among avalanche professionals, attention turned to education and outreach. Avalanche Canada's training curriculum and handbook were updated to incorporate avalanche problems into AST courses. Outreach materials were prepared that encouraged users to consider avalanche problems as a way to help select—or avoid—terrain (Fig. 3).

One memorable video made by Joe Lammers compared entering avalanche terrain to a boxing match in which you were a participant. The avalanche forecast was your coach and would give you information about your opponent—or what avalanche problem—you were about to face. Perhaps you would face Bruce Lee (a storm slab, maybe), Hulk Hogan (a cornice problem, perhaps), or a bear (a deep persistent slab, for sure). Either way, the idea was the information would help you manage the fight—the trip—and duck and weave in the right way to avoid being hit.

CURRENT USE

The Conceptual Model of Avalanche Hazard continues to be crucial for Avalanche Canada's work. It is the central framework under which avalanche hazard is analyzed and forms the basis of all our hazard discussions. It is used by our regional forecasters and our field teams for daily hazard assessments. Our current forecasting software, AvID, continues to employ the Conceptual Model at its core and our forecasts continue to include avalanche problems to help users better understand the nature of the avalanche hazard.

Despite offering a structured framework for avalanche hazard assessment, the Conceptual Model doesn't make an explicit link between the assessed problems and the danger rating. Avalanche Canada's forecasters assign a danger rating by first assessing the applicable avalanche problems, considering their relative contribution, then matching the sum of the hazard to the rating on the danger scale that best describes the conditions.

Under some conditions, particularly under moderate or considerable hazard, forecasters sometimes note that the *likelihood* description in one danger level matches well, but that the *size and distribution* description matches better with a different level. For example, under a low-probability/high-consequence scenario, a forecaster may assess there will be "large avalanches in isolated areas," which matches the size and distribution description for considerable, but that "human-triggered avalanches are possible," which matches the likelihood description for moderate.

This presents a challenging situation for forecasters, and one that lends itself well to future research. Avalanche Canada forecasters are coached not to under-value the size and distribution column in the danger scale, particularly when dealing with persistent weak layers and when the depth to these layers reaches the upper end of the triggerable range.

In education, approximately 11,000 people per year learn how to interpret avalanche problems and build skills that help them match the kind of terrain that is appropriate to ride under different conditions. As an outreach initiative, we recently built a presentation entitled "Considering Considerable," in which the idea of avalanche problems is explored to help users make decisions when the danger rating by itself does not give clear direction either way.

FUTURE USE

A key area of development for the future is snowpack modeling. It is already possible to query a grid and see a representation of the snowpack in many of the mountainous areas of Canada (check out *snowpack.avalanche.ca*. These models are also able to estimate the likelihood of encountering different avalanche problems and calculate a rudimentary index of danger. Future improvements to the danger estimation include a method that follows the Conceptual Model, estimating each of the required parameters to assess the size, likelihood, and contribution of each problem type.

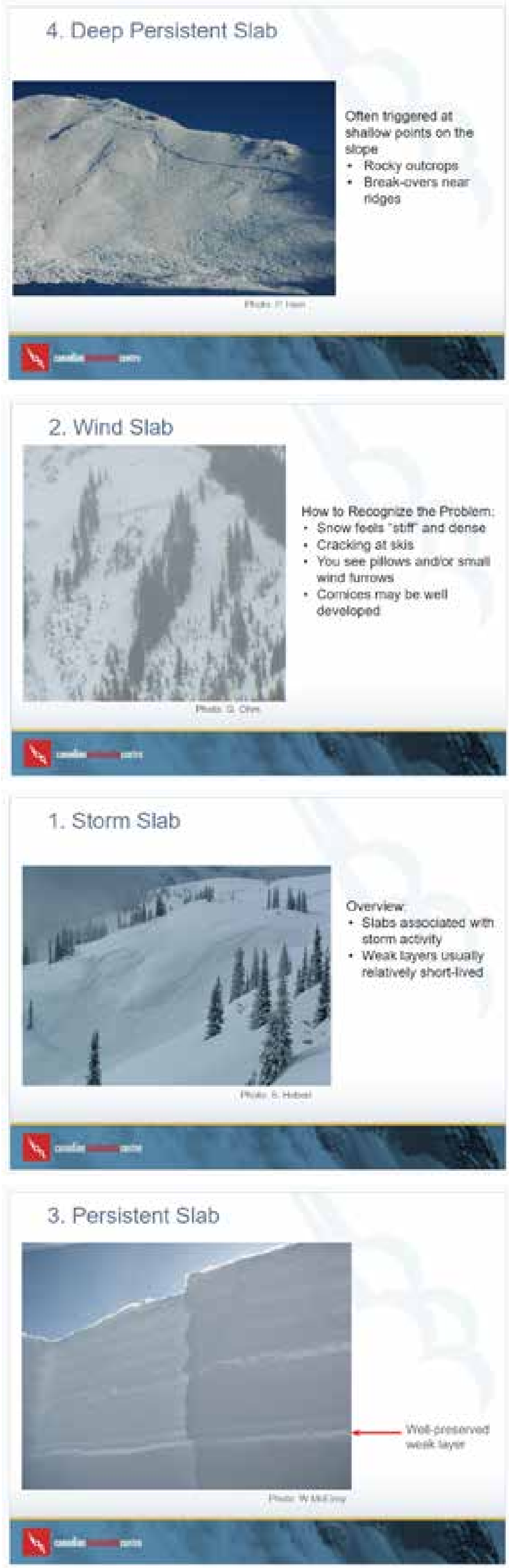


FIG. 3: PART OF A SLIDE DECK FOR AN OUTREACH PRESENTATION ON AVALANCHE PROBLEMS.

Notably, the avalanche problems currently predicted by snowpack models are those used by the European Avalanche Warning Services: new snow, wind slab, persistent weak layers, wet snow, and gliding snow. This is partly because much of the research into snowpack modeling is taking place in Europe. It's also because this set of avalanche problems is simpler, with less cross-over between one problem type and another. It will be interesting to see whether the growth in the use of snowpack modeling will lead to a change in the avalanche problems that underpin the Conceptual Model. Perhaps there may be an international convergence with Europeans adopting the Conceptual Model framework (which is not in widespread use there) and North Americans compromising with the stripped down—and easier to communicate—European list of avalanche problems.

SNOWPACK.AVALANCHE.CA 101

Avalanche Canada's snowpack modeling system uses the Swiss SNOWPACK model and inputs from the Canadian high-resolution weather model (HRDPS) to give forecasters a bird's eye view of the snowpack at a regional scale.

You'll notice a hexagonal grid covering western Canada's mountains, as well as the Chic Chocs in Quebec and Long Range Mountains in Newfoundland. These visualizations calculate snow profiles, rate the avalanche hazard, identify the major avalanche problems, recognize regional patterns, and more.

Since snowpack models rely on uncorrected weather forecast data, weather forecast errors may affect accuracy, making data validation essential.

To view a snow profile, click "Flat treeline" in the Snow Profiles section and select a grid location. Profiles display hardness and depth alongside a time-series showing seasonal snowpack evolution. If you select "Subregions," choosing a specific area provides averaged profiles for three elevation bands, timeline information, and a stacked display of individual profiles that reveals snow depths and weak-layer prevalence.

The Summary section offers an at-a-glance indication of avalanche hazard and avalanche problems, with grid cells coloured by values from zero (little contribution/hazard) to one (significant contribution/hazard). These values, calculated from an experimental algorithm still under active development, estimate avalanche hazard and the relative prevalence of each avalanche problem. Some of the site has been designed specifically for public avalanche forecasters, such as Clusters, which help forecasters combine subregions. It is important to use the information judiciously and in conjunction with field observations and expert interpretation.

Anything is Possible
Improving Likelihood Communication in Public Avalanche Forecasting

Andrew Schauer

INVESTIGATING THE CROWN OF AN AVALANCHE THAT WAS TRIGGERED ON A DAY WHERE WE EXPECTED HUMAN-TRIGGERED AVALANCHES WERE POSSIBLE. // JENNIFER COULTER

A FEW YEARS AGO, I was on a skin track with a friend who guides and forecasts for a local heli-ski operation. Their tenure bordered the advisory area for the Chugach National Forest Avalanche Center, the public avalanche centre where I forecast. We were talking about the avalanche danger for the following day, pondering the likelihood of someone triggering an avalanche on an early season persistent weak layer we were dealing with. With plenty of time to kill before we got to the top, we had a chance to get into it. As we ascended, we realized how challenging likelihood was to communicate among a team of professionals, which really made us wonder how effective the likelihood component of the forecast could be as a risk communication tool for the recreating public.

Fast forward a few months, and I was catching up with a friend who was forecasting for a public avalanche centre in Idaho at the time. He recounted a conversation with one of his friends, an experienced ski patroller and avid backcountry skier, who told him something along the lines of, “I’ll start reading your forecasts as soon as you stop telling me avalanches are ‘possible.’”

Hmm…

This was all around the same time other avalanche professionals had been exploring uncertainty in likelihood communication (e.g., Tart, 2018; Thumlert et al., 2019). It was also shortly after the Conceptual Model of Avalanche Hazard (CMAH) was published (Statham et al., 2018), which has provided a framework that substantially improves our ability to communicate some of these issues within our operations. However, it was clear there was still work to be done to resolve some of the issues tied to communicating risk likelihood.

Two years ago, I started reading some of the existing research on likelihood communication outside of the avalanche world. This included a large body of work in the fields of psychology, climate change, public health, and statistics, to name a few. I convinced a group of avalanche professionals to put something together for ISSW 2023 that would continue the conversation where Tart, Thumlert, and others had left off a few years earlier. We dug into the psychology of risk communication and used that lens to look at the current state of public avalanche forecasting in the U.S. We proposed some ways to resolve ambiguity in our forecast products, thereby making public avalanche forecasts more useful to the recreating public. Our key points are reviewed in this short article; the full ISSW paper can be found with the QR code below.

THE PSYCHOLOGY OF LIKELIHOOD COMMUNICATION

Researchers have investigated how people communicate risk likelihood since the mid-1900s (e.g., Simpson, 1944). While previous work has covered a broad range of topics, our project explored three topics that are most relevant to communicating likelihood in avalanche forecasting:

1. Numerical ranges people tend to associate with commonly used verbal probability expressions (VPE).
2. Our preference for a method of communicating likelihood.
3. The way our emotions affect our interpretation of risk likelihood.

One thing that has been reproduced several times in the literature was that people assign a very broad probability range to intermediate expressions like possible or likely (e.g., Tiegen et al., 2014; Wallsten et al., 1986). The term 'possible' is by far the worst offender—people have associated it with as low as a 10% chance of an event occurring and as high as 90% or greater. On the other hand, we are actually in fairly good agreement with VPEs closer to the extreme ends such as very unlikely or almost certain.

While there is a large body of work exploring numerical ranges for VPE, we also know our preference to communicate probability in terms of a numerical range versus a VPE changes based on the nature of the uncertainty we are dealing with and whether we are speaking or writing. For example, Juanchich and Sirota (2019) found that when given scenarios involving epistemic uncertainty (stemming from lack of knowledge on the subject matter) or dispositional uncertainty (requiring a causal assessment stemming from personal predispositions), participants preferred to communicate uncertainty with verbal descriptors. However, for questions involving distributional uncertainty (related to the physical properties of the world), participants preferred to communicate uncertainty numerically. They also found participants were more likely to communicate uncertainty with verbal expressions orally, and more likely to communicate similar uncertainty numerically when writing.

There is also a good amount of work demonstrating that our perception of probability depends on the severity of the circumstance at hand and how the situation is framed. Harris and Corner (2011) found we tend to infer a higher percent chance of an event occurring when the consequences of the event are more severe. In a similar vein, Tiegen and Fikukova (2013) described the difference in the way we interpret the likelihood an event can occur versus the likelihood an event will occur. They explained people tend to interpret the likelihood an event can occur as less likely than an event that will occur. This has implications in how we communicate avalanche likelihood to the public—there is a meaningful distinction between discussing the likelihood a person can trigger an avalanche versus the likelihood a person will trigger an avalanche.

RISK COMMUNICATION IN AVALANCHE FORECASTING

Jamieson et al. (2009) derived estimates of the probability of a skier triggering a potentially fatal avalanche for each of the five levels of the North American Public Avalanche Danger Scale (NAPADS), assuming the skier had no experience with route selection in avalanche start zones. He estimated probabilities of 0.00001 to 0.0001 at low danger (human-triggered avalanches unlikely), 0.0001-0.001 at moderate danger (possible), 0.001-0.01 at considerable danger (likely), 0.01-0.1 at high danger (very likely), and 0.5-0.75 at extreme (certain). These estimates differ by several orders of magnitude from the survey data summarized in both Tart (2018) and Thumlert et al. (2019), which have similar estimates with median values of approximately 0.1 for unlikely, 0.3-0.4 for possible, 0.6 for likely, 0.8 for very likely and 0.9-0.95 for certain.

This discrepancy is likely a result of a disconnect of scales. Whereas Jamieson et al. (2009) estimated the odds of a single skier triggering an avalanche, there is a good chance most of the people interviewed in Tart (2018) and Thumlert et al. (2019) were considering the odds of any person triggering an avalanche across an entire forecast area. This highlights a major gap in our current system—we have never defined the likelihood we are estimating.

In an effort to resolve the ambiguity inherent in the way we currently communicate likelihood, Thumlert et al. (2024) proposed a framework to define the likelihood we are estimating ("the chance of the start zones being assessed releasing within the forecast time period, regardless of avalanche size"), as well as a means of assigning numerical probabilities to a set of VPE. While the exact definitions, terms, and numerical ranges can and should be refined, this approach is a major step forward in resolving the extra layer of uncertainty stemming from the ambiguity of our current system.

CONCLUSIONS AND A PATH AHEAD

The focus on calculating and assigning specific probabilities to the likelihood expressions included in NAPADS ignores a key fact—the only evidence-based tool we currently have to estimate likelihood is based on an assessment of the sensitivity and distribution of a given avalanche problem as defined in the Conceptual Model of Avalanche Hazard.

This lacks a quantitative approach to a numerical estimate of probability. Although an assessment of sensitivity and distribution is largely subjective and relies on inductive reasoning, the definitions laid out in the CMAH are clear and carry much less ambiguity than the likelihood terms we derive from these properties.

Considering this, we avalanche practitioners should ask ourselves what we gain by translating two tangible (and somewhat measurable), qualitative snowpack properties into one pseudo-quantitative descriptor that carries a large degree of ambiguity and has been repeatedly demonstrated to be a poor communication tool. Might it be more effective to shift our communication strategy and focus on these less ambiguous properties by placing an increased emphasis on the appropriate travel advice, thus providing the user with more tangible information for a given avalanche problem and a way to manage that problem?

In light of everything discussed previously, we might consider the following for improving our means of communicating likelihood in public avalanche forecasts:

- Encourage forecasters to place more emphasis on messaging related to travel advice rather than avalanche likelihood, especially when the likelihood lies in the most ambiguous intermediate ranges, rather than on the ends of the spectrum.
- Rectify potential differences between the CMAH and NAPADS. Make it clear to the public that there are instances where the travel advice, likelihood, and size/distribution columns do not align, and that we will fall back on travel advice when there are discrepancies. This can be a simple statement at the top of the danger scale. For U.S. avalanche centres, this appears explicitly in forecaster guidance provided by the USDA Forest Service National Avalanche Center: "When conditions do not fit neatly into the criteria (Travel Advice, Likelihood of Avalanches, and Avalanche Size and Distribution) for a single danger rating, then the choice of a danger level should be primarily based on the travel advice." However, it is absent from NAPADS.
- Eliminate the phrase 'possible' from NAPADS and from our messaging. Consider replacing it with a modified likelihood descriptor such as less likely or less than likely.
- Train forecasters and the public on set definitions for the verbal descriptors. This includes emphasizing the concept that, as of now, these terms are qualitative descriptors with no current assigned numerical ranges and no reliable quantitative approach towards estimating numerical probability of avalanches.
- Work as a group to refine the definitions and terminology proposed in Thumlert et al. (2024) and establish standard guidelines for avalanche professionals in North America.

GRAHAM PREDEGER ENJOYS SOME SNOWMOBILING IN MELLOW, NON-AVALANCHE TERRAIN IN PLACER VALLEY, ALASKA. TRAVEL ADVICE SHOULD BE EMPHASIZED OVER LIKELIHOOD OF AVALANCHES WHEN LIKELIHOOD IS AMBIGUOUS. // ANDREW SCHAUER.

Along with the suggestions mentioned above, users may benefit from improved transparency in our decisions that go into selecting danger ratings and assessing likelihood. While we may accomplish this in the discussion portion of daily avalanche forecasts, there is also room for improvement in avalanche education. For example, it may be beneficial to introduce the CMAH distribution/sensitivity and size/likelihood matrices earlier in the avalanche education progression, and potentially share some of the existing National Avalanche Center forecast guidance with education providers. Part of the users' difficulty in interpreting the likelihood statements can be compounded by not knowing what happens in the CMAH workflow or by misunderstanding the fact that our likelihood statements are qualitative rather than a numerical description of probability.

Ultimately, we are trying to provide people with information to make informed decisions while they are out in the mountains so they can come home at the end of the day. NAPADS is a great tool for communication, but if we rely too heavily on the likelihood component, we are falling short of our mission. We can take lessons from a large body of existing work in psychology and communication to make our products more effective.

Hopefully this article keeps the discussion moving forward. After spending the past few years working on this with a broader professional crowd, I am pretty sure ours wasn't the first (or last) skin track conversation lamenting the challenges and shortcomings of our current means of communicating risk and likelihood. Now the challenge is to combine our skin track conversations, learn some lessons from other fields, and work together as a professional community to improve our current systems.

ACKNOWLEDGEMENTS

This work was a result of a collaboration with Aleph Johnston-Bloom, Simon Trautman, Eeva Latosuo, Alex Marienthal, and Ben VandenBos, with additional insight from John Sykes, Zach Guy, and Karl Birkeland.

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snow globe

43

**CAA HISTORY PROJECT:
JACK BENNETTO**

// DOUGLAS NOBLET

CAA History Project
Jack Bennetto on the Creation of the CPD Program

Alex Cooper


JACK BENNETTO.
// PHOTO CONTRIBUTED.

JACK BENNETTO BEGAN his avalanche career working at Rogers Pass in the mid-70s, followed by guiding with CMH and Alpine Guides, New Zealand in the early-80s. He started working for the BC Highways avalanche program in 1984 and led it during the construction of the Coquihalla Highway. He then managed the provincial avalanche program for BC Highways, overseeing its growth until 2002.

Jack has been a proud member of the CAA since the mid-80s and was President from 1995–1997. Jack's accomplishments as President of the CAA include the development of the CAA's Continuing Professional Development program, the Avalanche Mapping courses for professionals, and the introduction and adoption of the five-level avalanche hazard scale, among other things.

In this excerpt from our interview for the CAA History Project, he talks about his initial involvement with the CAA and the pressures the association faced from other groups that led to the establishment of the continuing professional development program.

Alex Cooper: What brought you to get more involved with the CAA? We're looking at the early '90s here.
Jack Bennetto: I guess I just wanted another challenge. I really enjoyed how dynamic and open and private-sector-focused the CAA was. I was not so thrilled with how staid the provincial government is to work for, so I found a lot more stimulation with the dynamic group of people of the CAA that I didn't get working for the Province of B.C, amongst others.

That was probably just as much as plain loving avalanches, loving snow, and wanting to be involved. It was very different than government, and I really enjoyed how dynamic the CAA team was, and all the decisions and things we did, and what we did to make things change. I thought that was great. Government is so huge, probably its problem is that it's simply hard to move things there. It was the opposite in the avalanche association.

It's interesting doing these interviews, especially looking at this period. The CAA in the '90s was 10–15 years old, still a pretty young association, trying to figure out what it means to be an association and be avalanche professionals. Did you find that at all?
For me, it was what does it mean for the association, learning a bunch of protocol and legal rule sets. I think you mentioned that during my tenure, there was the Art Twomey helicopter crash, and so you learn a lot about legal stuff in a big hurry there because some of the people who were students were American, so the American legal system was presented to me in a big hurry right after that. It was a growth and an education for all of us.

In my tenure, there was also some challenges from the Association of Professional Engineers at that time, and I deemed that a threat to our vision of who professionals were for the snow avalanche industry. I thought we needed to pull up our socks as well as defend our position on the way it worked—everybody did. That was a growth period for policy and legal positioning.

I find that an interesting aspect. You had that Association of Professional Engineers and Geoscientists BC poking their fingers into avalanche work and saying you need to be an engineer to do avalanche work or supervise avalanche work. It sounds like that was a pretty big—maybe fight isn't the right word—but something you had to deal with, to defend, the skills of avalanche professionals, become independent. What was that like dealing with those outside pressures?
Another education for me. I learned a lot about professional engineers. They were, I believe, opening up limited licensing, so they were putting up new territory for themselves. I also understand that was a period where they were doing the geoscientist part of that, so they were expanding. Their push from their board was to expand their territory. That opened the dialogue where they were going to expand, and some of that had the word "avalanche." Some of the comments were that you needed to be a member of the engineer's association because avalanches were a natural hazard, and they should be engaged with that piece.

There was a lot of background dialogue anyways—I don't know about hard-written threats—that they should have that responsibility and territory. They were the ones that had the education and skillset for that, and maybe all the avalanche people needed to be overseen by some kind of engineer to sign off and forecast. Certainly, most of the people took exception to that in the CAA. I certainly did, because I thought our people did a pretty darned good job.

That's what rolled out with the continuing professional development program. I thought, and the board thought, we needed to have that. We needed for that piece to be more professional than we had represented ourselves before to make sure we were worthy of doing professional avalanche work. That didn't mean taking over impact pressures on homes and buildings, and what I deemed true engineering, but it did mean we should do a lot better job of understanding what we can deliver and what we can't. That was where the professional development program came from, and I feel pretty darned good that I managed to pull that off with the membership and adopted it before I moved on.

Now that's a key part of being a member, maintaining a certain level of CPD to maintain your membership in the CAA, and that started in the mid '90s.

It was wide-ranging. Some people didn't like it but some of the management of some of the bigger businesses that were avalanche related were very supportive, and they were going to happily implement that for anybody they hired. It became a huge tool for safety in the industry and it especially helped all of us with WorkSafeBC. They used that as a tool to measure our performance.

I liked what we did there because it's defining what the performance piece is, and that's our target to measure, and the outside world needs that. I know it's changed, but it hasn't changed a massive amount, so it's getting better and better. I'm pretty proud of pulling that off.

JACK IN SVALBARD, NORWAY, ON A FIELD TRIP FOLLOWING ISSW 2026 IN TROMSO. // GEOFF FREER

I want to get back to your conversation with the engineers. I read an article from the summer of 1995, which would have been when you became President, talking about your discussion with them and coming up with three categories of avalanche work: designing structures for avalanche protection, planning avalanche safety programs, and then the actual carrying out of avalanche programs.

Those were deemed three categories of avalanche work, but only that the first one and maybe the second would involve an engineer. Avalanche professionals could go ahead and drop bombs, and do avalanche control, and day-to-day forecasting on their own without an engineer around. Do you remember how that came about?

I just think the engineers association had that position. We pushed back that most of those categories should be the practitioners. I had many meetings with them to understand what their target was, and to present what I thought—and we thought—the avalanche industry could deliver and should deliver. I used examples like in Europe, it's the meteorologists and the professionals in weather that do the forecasting, not the engineers. There was a lot of dialogue around, "Is this structural engineering, natural hazard protection, or is this a weather protection?" Really, it's both.

But our avalanche forecasting practitioners, which was the way we all grew up under Peter Schaerer and others, are really more weather-focused. Engineering, I would still see that as longer-term hazards like geohazards with serious impact pressures. That was the constant dialogue. All I can think of is there was never a final decision that we made, or they made, but I think we (collectively) made ourselves more professional by our programs and we could define them.

One of the defining things is the CPD program of a professional association of any sort. That put us in a better place to represent ourselves to be able to do what our skills are. It was a multi-year saga of continuing dialogue. I noticed Clair Israelson and others worked on that (further clarifying responsibilities) after I was no longer President. I think we understand our territories and we work well with the engineers, which in those days, in the '95–97 era, felt a lot more like threats from my understanding. They weren't comfortable meetings most of the time.

JACK BENNETTO AND A COLLEAGUE SET UP THE RECOILLESS RIFLE ON THE COQUIHALLA HIGHWAY. // PHOTO CONTRIBUTED

The CAA is 15 years old, or not even at this point, so I imagine there's a bit of an unknown. When I talked to Bruce Jamieson, one of the comments he made (relating to CAA members) was, "Who are these guys and how skilled are they?" So, enhancing the professionalism and skill set of avalanche workers must have been a fairly big focus.

Yes, some people weren't very happy being asked to meet those criteria on the CPD piece then. Bruce Jamieson—I have huge respect for him—he had his foot in both camps, teaching engineering, so he was part of helping define that breakdown on what the practitioners' piece is and what the engineers' piece is. At times, I'd hire avalanche engineers for hazard works when I became a Director of Emergency Programs for Earthquake Preparedness, and my staff as a highway manager would sign off subdivisions, and those need engineering, there's no question. Would that house get blown apart or not? We would hire people like Bruce Jamieson and others to make those decisions, but they also worked with the avalanche practitioners. It was a long grind, but I think the process and definitions ended up working pretty well for public safety and avalanche understanding.

You're the manager of the highway avalanche program at this period, so you must have been working with engineers and avalanche technicians in your own professional life. Could you see both sides? How much did you actually work with engineers when you were managing that program?

Not a lot, and I think it's just because we were more focused really on highways and highway construction and civil and concrete and designs more than the natural hazard piece.

A fallout I also am somewhat proud of was the Advanced Avalanche Terrain course that came out of that. Technicians, primarily CAA Professional Members, could be part of that process and work with engineers, who would make the ultimate call on if that is going to be a hazard to people and infrastructure from impacts. That process defined criteria for zoning, which we really didn't have before. Clair Israelson helped us get grant funding for building those courses and defining those criteria, and Bruce Jamieson and others participated in writing those criteria for zoning.

Then I distributed them—or we did from the CAA—to all the governments and jurisdictions throughout Canada that do natural hazards. We did that for British Columbia also, so the vast majority of those approving bodies and regional districts use those criteria for helping guide their decision-making for zoning for subdivisions primarily. We did that in that era, and I think that's pretty great that that was done with our association members who are engineers and practitioners.

For the full video and transcript of our interview with Jack Bennetto, visit avalanchejournal.ca.

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