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in this **issue**

Walter Bruns
CAA President

President's Message

COMPETENCY-BASED MEMBERSHIP: OUR JOURNEY SO FAR AND YOUR VOTE TO TAKE THE NEXT STEP

AS YOU READ THIS, you should have received notice of the proposed bylaw changes to be voted on at the AGM. They mainly focus on new competency-based requirements for members.

They are the culmination of years of work by members like you who have sat on committees and the board, and worked with staff and contractors towards a competency-based membership framework.

To both honour these efforts and illustrate this history, it is worth looking back. Around 2013, it became clear the qualified avalanche planner (QAP) membership category did not serve the membership as well as originally intended. It focused much effort and resources on an elite group of members. Meanwhile, WorkSafeBC avoided enacting an earlier version of its Occupation Health & Safety regulation 4.1.1 that recognized QAPs; even members with this designation saw little benefit from the category.

As this took place, there was not much focus on defining membership in terms of self-regulation, or competency. Employers, agencies, and the public would call the CAA seeking to understand the competency of members from different categories, and we had only vague answers and references to course outcomes.

In 2014, the CAA started a journey to define what services members could perform through the development of the competency profiles you have heard so much about since then. Through the hard work of group of subject matter experts (SME), competency profiles describing eight domains of skillsets were presented in 2015. Two profiles were developed: P1 (roughly corresponding to active members) and P2 (roughly corresponding to professional members). These profiles described the minimum set of abilities of these categories *at the moment the applicant becomes a member*.

With the profiles in place, the work had only begun. Staff worked with various committees and SMEs to develop a gap analysis to help us understand where the Industry Training Program was already addressing the bar set by the profiles, where it could meet the needs in the future with some changes, and where assessment would need to take place outside of the ITP. This work defined how the ITP needed to change. It allowed us to successfully apply for funds from the National Search and Rescue Secretariat's Search and Rescue New Initiatives Fund (SARNIF) for the Competency-Aligned Avalanche Risk Assessment Training (CAARAT) project.

CAARAT is coming to completion this spring after three years in which Avalanche Operations Level 1 and Level 2 courses have been overhauled. The first cohort of students took the revised Level 1 this season. The first Level 2 cohort will begin next season. To complement these courses, ITP also developed an online Introduction to Avalanche Operations to give more classroom and field time to key Level 1 concepts.

Not all competencies could be addressed in ITP. Outside of the regular ITP stream, we have created Introduction to Professionalism, an online course that will be required of all applicants to introduce the ethical context of avalanche practice.

The biggest change is the introduction of a workplace portfolio. The gap analysis consistently noted many competencies could not be evaluated in the classroom—even with field-based courses. The portfolio allows applicants to gather evidence to support a workplace description that meets the competencies not covered in ITP or the professionalism course.

As this journal heads off to print, a second round of volunteers is testing the whole application process including the workplace portfolio at P1 and P2 levels. They have helped us learn what works and what could be improved. Overall, volunteer applicants using the process have found it valuable in helping to reflect on their practice, and to understand where they are and what they can competently perform in the workplace.

This journey has got us to a place where we have new courses and a new application process waiting to go. We still need to modify the CPD process to align with the application process so the work spent on the application can be harnessed into a member's annual CPD work. That is yet to come.

In the near term, we must pass bylaws to enable this process to go ahead. These proposed changes:

- Allow the board to define the coursework required of new applicants.
- Allow the board to define the requirements of a workplace portfolio.
- Recognize existing members who remain in good standing without the need to meet the new membership requirements.
- Set a date for the new application process to take effect.

The bylaw changes before you seek to balance the need of the membership to endorse the requirements I note above, with the ability of the board to change specific details related to curriculum or the administration of membership applications.

This is the journey we have been on together to build a strong process for competency-based membership. It can only go ahead with your approval as members. I encourage you to support this work at our vote this spring so we can begin the next chapter in our association's proud history of excellent service in the public interest.

Walter Bruns, CAA President

Joe Obad
CAA Executive Director

Executive Director's Report

MAKING THE MOST OF ONLINE TOOLS FOR VOTING, ITP, AND INFOEX

THE LAST FEW YEARS have given online tools a bad rap. There is no shortage to worry about: social media is killing civil dialogue, articles on spam encourage us all to all but give up on email, hackers and faraway political operatives are out to get us, and more.

However, there remains much good to mine. If we approach these tools with balance, we can still use online experiences to address fairness, time constraints, and focus.

The CAA is pursuing a targeted use of online tools to connect better with members and offer better services. Let's take a look at some recent changes.

This edition of *The Journal* touches on several points related to the CAA's professional path towards better self-regulation. Project manager Kathy McKay outlines the volunteer membership application processes members have been test driving to ensure we are ready to go, subject to member approval. President Walter Bruns' piece outlines the history leading up to the votes for members this spring.

In the past, such a significant vote would be conducted by those attending the spring AGM. This limited us to some degree to being, "The Canadian Avalanche Association of Those Who Can Afford to Get to Penticton," because the voting franchise was not extended to all voting members reasonably.

To ensure the whole membership has a say in important changes, we are moving to support more online voting. Online voting will be enabled for the special motions provided 21 days in advance of the 2020 AGM, and should be the norm moving forward. For the 2020 AGM, if you wish to vote for the special motions, you can do so during the time of the meeting. Mixing meetings with online and in-person attendees is challenging, so the board and staff will need to do more work on the feasibility of a mixed live meeting.

The CAA's bylaws in their current form do not yet allow voting in advance of the meeting. We hope to get the membership's approval to make additional changes to the bylaws to allow advance online voting as well.

Beyond voting, we now have two Industry Training Program courses online: *Introduction to Avalanche Operations* and the proposed membership pre-requisite course, *Introduction to Professionalism*.

The first allows students to gain initial exposure to concepts they will need to advance further in Avalanche Operations Level 1. This online course is a prerequisite for the Level 1 course. *Introduction to Professionalism* offers membership applicants and members a reference point for the professional and ethical responsibilities of membership in the CAA. Ideally, we would have lengthy workshops on this topic, but online tools allow applicants to prove initial competency on this topic.

You may have glanced at my title and thought, "InfoEx is already online! You can't mention that!" Hang on. From the beginning of the current version InfoEx, we've known we were under-using mobile apps and connectivity from external data sources.

I am so proud of our InfoEx team for two recent advances: Mobile InfoEx and automatic weather feeds. Mobile InfoEx currently allows subscribers to enter observations from the field and have it ready for processing when returning to base. Automatic weather feeds allow participating operations to feed weather data directly to InfoEx for processing. Both advances reduce transcription and free up operational staff to focus on urgent operational concerns.

These are just a few online advances we've made to serve you better. I hope to see many of you at the Spring Conference. Don't take what I've offered here as permission to send your robot in your place!

Joe Obad, CAA Executive Director

Alex Cooper
Managing Editor

The Future

AS A JOURNALIST, I like to think my work is immune from automation. Can a computer really capture the nuance of a news story? Can it be programmed to recognize what part of a story has the highest news value, which quotes are the most significant, and how to pull relevant background information? At the very least, a human has to conduct the interviews and do the research, right?

In fact, computers are being used to write articles by several news agencies. "Automated journalism," as it's called, is being used by several major media outlets to write sports recaps and financial stories. For example, this sentence was generated by the *Washington Post's* Heliograf software: "In the second quarter, The Patriots' Paul Dalzell was the first to put points on the board with a two-yard touchdown reception off a pass from quarterback William Porter."

This is basic reporting, but it would be naïve to think AI and machine-learning won't play a bigger role in journalism. According to an article in *Forbes* by Nicole Martin, Heliograf can alert journalists to trends in big data sets to help them focus their energies. The *LA Times* is using AI to produce work on earthquakes and murders. Fortunately, writes Martin,"The media outlets using the AI say that this is a way to assist journalists in high-value work rather than replace them and no jobs have been lost to these robots as of yet or in the seeable future."

I muse about this because a central article in this issue looks at the future of avalanche forecasting by comparing it to advances in weather forecasting over the past century. New technologies that will impact the work of avalanche professionals are slowly coming into play, but they aren't part of the daily process yet. Virtual snow profiles, exist, but they aren't reliable yet. As Simon Horton writes, "Computers are great at pattern recognition—better than humans in many fields—but thankfully avalanche forecasting is more than that. Computer predictions will need to be verified, interrogated, and interpreted by humans, and ultimately the complex mitigation decisions are up to us."

I expect Simon's article will spark many discussions, and I hope elements of it will be written about in greater detail in future issues of *The Avalanche Journal*.

MEMBER SURVEY RESULTS

Thank you to everyone who answered questions about *The Journal* in our member survey. The results are very encouraging. Ninety per cent of respondents read all or part of each issue, and most of you had positive feedback. There were calls to have more and a wider spectrum of content, so that is something I will work towards.

Case studies were seen as the most valuable aspect of the magazine, with over 80% of you considering them either "very valuable" or "essential." Research articles and field reports were also highly prized.

When it comes to new styles of articles, there wasn't much of a consensus. Between 40–50 percent of you would like to see gear reviews, trip reports, event reports, and book reviews. One person asked for, "More pictures of stern but lovable CARDA dogs," so they'll probably really enjoy Adam Sherriff's article about his dog Brooke's role in the Howse Peak avalanche recovery.

All feedback will shape future issues, and I hope to continue producing a magazine you enjoy reading.

DIGITAL TRANSITION

We also received some feedback to make *The Journal* digital only. We believe in the value of a printed product, both for our readers and advertisers, but we are making moves to making *The Journal* available online. I've started posting one past article weekly to the Avalanche Journal Blog, which you can find at avalancheassociation.ca/page/TheAvalancheJournal.

Additionally, we've been digitizing as many past issues as possible (going back to 2005 so far). These will soon be available at issuu.com/theavalanchejournal. The three latest issues will be available for members only, while the rest will be open to the public. You can find the link in the "members only" section of our website.

THE AVALANCHE JOURNAL ADVISORY GROUP

I am seeking to re-establish an advisory group to help devise themes and article ideas for *The Avalanche Journal*. The goal is to gather together a group of CAA members representing a diverse range of industry sectors and geographical regions. We will meet two or three times per year to discuss story ideas and potential authors. If you are interested in joining, please email me at acooper@avalancheassociation.ca.

Alex Cooper

Fall 2019 Member Survey: A Recap

Jess Landing

LAST FALL, the CAA conducted a comprehensive member survey for the first time since 2011. Nearly a decade has passed and major changes have taken place since then. Notably, the Canadian Avalanche Association and Avalanche Canada became independent organizations (a shocker for some, we know!) Still, our association's mission to ensure that our diverse membership of avalanche practitioners meets the highest standards and adheres to best practices to secure the confidence of governments, industry, and Canadians has remained steadfast.

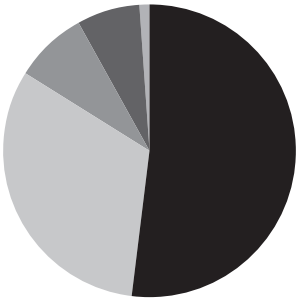
The intention of this survey was to gain a better understanding of our membership, take a closer look at what our members are looking for, and see what benefits they want from the CAA. We are also using some of the information to boost our partnership program.

A huge thank you goes out to everyone who took the time to respond. We had 238 members fill it out—a nearly 20% participation rate! As we move forward, we will use the findings from the survey to better guide our efforts to meet the needs of a growing membership and industry.

We will be working hard to make changes that reflect the desires of our members. Stay tuned for updates in the monthly member newsletters and *The Avalanche Journal*.

MEMBERSHIP BREAKDOWN BY CATEGORY

PROFESSIONAL: 53% (678)
ACTIVE: 32% (410)
AFFILIATE: 8% (104)
ASSOCIATE: 7% (91)
HONORARY: 0.5% (6)



HERE'S A LOOK AT WHAT YOUR CAA MEMBERSHIP LOOKS LIKE IN 2020

Years of Membership: 36% of our members have been a CAA member for 10 years or more.
International Reach: CAA members work in 23 different countries around the world.
Percentage of our members in other organizations: ACMG: 40%, SAR: 36%, ACC: 25%, CSGA: 15%

Membership **wants**

- Mentorship opportunities
- Scholarship opportunities
- Increased CPD and educational opportunities
- Increased communication of industry updates

What we're **working on:**

- Using member survey feedback to better communicate the needs and interests of our membership to current and prospective partners
- Exploring leads to build scholarship opportunities for members
- Researching options to meet demand for additional CPD opportunities.

MEMBER FEEDBACK

"Very proud to be a member, and use the association as an example to others as to how a member-driven society can be."

"We are ski-patrollers, guides, and avalanche techs with the odd engineer thrown in. Keep shooting for excellence and inclusiveness, but don't make it too complicated!"

Competency-Based Membership: **The Transition Is Here**

Kathy McKay

AFTER MORE THAN SIX YEARS WORK, the CAA's transition to a competency-based membership is becoming a reality. An optional competency-based membership (CBM) application process has been made available to members since February 11. At this May's AGM, members will vote on bylaw changes that enable the membership committee to use the requirements—tested in the voluntary process—for future new member applications.

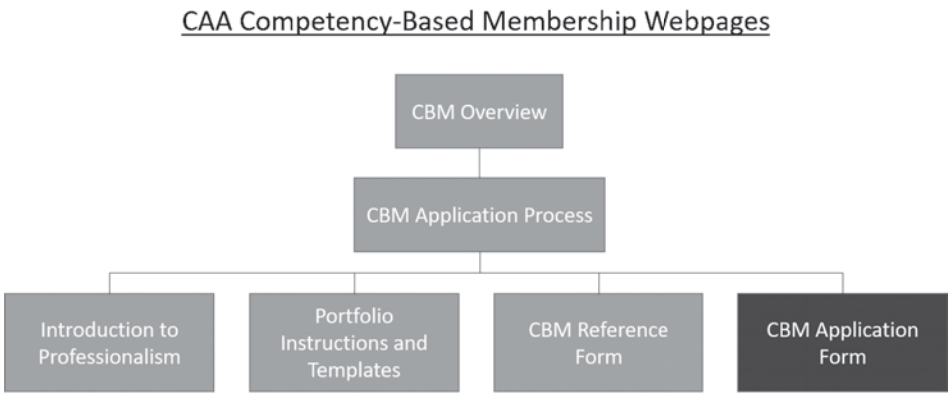


FIG. 1 WEBPAGES PROVIDING BACKGROUND INFORMATION ABOUT THE CAA'S COMPETENCY-BASED MEMBERSHIP (CBM) ARE NOW AVAILABLE ONLINE AT WWW.AVALANCHEASSOCIATION.CA/PAGE/CBM_COMPETENCYBASEDMEMBERSHIP. DETAILS INCLUDE ACTIVE AND PROFESSIONAL APPLICATION REQUIREMENTS, APPLICATION INSTRUCTIONS, TEMPLATES, SAMPLE PORTFOLIOS, AND FORMS.

Individuals applying for active or professional membership currently have the option to use the new competency-based process on a voluntary-basis until the AGM. This optional-use period will enable the CAA to fine tune the staff and committee procedures before the associated bylaw changes are presented for vote at the AGM (see President Walter Bruns article on page 8). Volunteer applicants will also get a jump start on assessing and developing their workplace portfolios. Note that everything below is subject to members approving the bylaw changes at the AGM.

The new membership application model centres on a set of competency profiles, first released as drafts in 2014 and recently updated. The competency profiles and proficiency scale are snapshots of the minimum abilities required when entering two levels of membership[1]:

- Practitioner 1 (P1), which correlates most closely to the current active membership).
- Practitioner 2 (P2), which correlates most closely to the current professional membership).

Information about the CAA's journey towards a competency-based membership, including the updated competency profiles and proficiency scale, competency-based application requirements, and detailed application instructions, are now available on the CAA's website. Figure 1 above provides an overview of the new webpages and the related application components.

These competency-based options do not replace the existing membership requirements. The membership committee and staff thoroughly reviewed the requirements and found the new ones are consistent with the minimum requirements of the current process, which applicants can still use until the AGM. The main change to the requirements for membership applications is the addition of an *Introduction to Professionalism* course and a workplace portfolio.

Similar to the new *Introduction to Avalanche Operations* course, the professionalism course is offered online and consists of a series of self-directed learning modules and quizzes. This course will be used to address the competencies within the professionalism domain of the P1 and P2 competency profiles. It covers topics such as the CAA's governance model and bylaws, the CAA Code of Ethics, and a member's scope of practice.

Currently, the course is only offered to those who volunteer to apply for membership using the competency-based process. However, following acceptance of the new bylaws, this course will also be provided as continuing professional development to existing members.

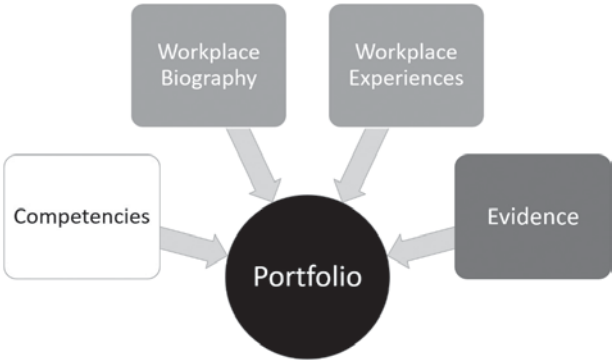


FIG. 2 APPLICANTS USING THE COMPETENCY-BASED MEMBERSHIP PROCESS CREATE A WORKPLACE PORTFOLIO. USING THE PROVIDED COMPETENCY TABLE TEMPLATE, APPLICANTS LINK THEIR WORKPLACE BIOGRAPHY, DESCRIPTIONS OF EXPERIENCES AT WORK, AND EVIDENCE TO THE REQUIRED COMPETENCIES.

[1]P1 and P2 are placeholders until new category names are voted upon and approved by membership. Until that time, successful membership applicants will be granted active or professional membership status accordingly.

Competencies required for new applicants, but not assessed in the Industry Training Program (ITP) or the *Introduction to Professionalism* course, are addressed through the workplace portfolio (Figure 2). For each competency addressed by the portfolio, applicants must show they meet the required proficiency level through their workplace biography and experiences. Where needed, applicants must provide evidence and/or third-party validation that confirms what they have written. It is important to note that, in many cases, a single experience or a single piece of evidence can address multiple competencies.

The competency project team has already received numerous excellent questions and comments—and completed applications—from volunteers using the competency-based process. Using the feedback we receive from volunteers, committees, and staff, we will refine the application and assessment process. Results will be presented with the supporting bylaw changes at the AGM. In the meantime, all questions and comments are welcome. We owe a huge debt of gratitude to all of those who volunteered their time to help us become closer to attaining one of CAA's strategic goals. Thank you!

ITP Level 2 Program Update

Emily Grady

THE LEVEL 2 PROGRAM IS UNDERGOING SOME CHANGE

As described a year ago in *The Avalanche Journal*, the Level 2 program has been reconfigured. Instead of three modules, there will be two components: a course, and an assessment. The course combines the current Modules 1 and 2. The assessment is the same as the current Module 3, where students' skills and competency in both technical knowledge and practical application of Level 2 concepts are evaluated. Also, although similar to current Level 2 modules, the new curriculum has been modified to align with the CAA's new competency profiles.

BENEFITS AND CHALLENGES

As with any change, there are benefits and costs, as well as implications for students. Below are some of the benefits and challenges that were identified by the Level 2 working group.

BENEFITS

- Ensures a more fluid learning progression from concepts to application, integrating theory into practice.
- Provides better continuity and opportunity for instructors to provide feedback due to the reduction of time spent reviewing prior learnings.
- Reduces student expenses with fewer sessions to attend (two versus three modules).

CHALLENGES

- Students having to attend a seven- to eight-day course during winter.
- Shifting between field and classroom days may make it harder to track weather and snowpack conditions.
- Limits on course enrolment (18 versus 30-36 on the current Module 1).

Ultimately, it's recognized more time off during winter comes at a cost to both students and employers. However, it was deemed the benefits outweigh these costs with increased course quality and overall educational experience.

IMPLICATIONS FOR STUDENTS

Level 2 students who are in the program already and have completed a Module 1 and 2 this winter will be able to register directly for the Level 2 assessment for winter 2020-21. Leve 2 students that have completed the Module 1, but not the Module 2, must register for the new Level 2 course.

New Level 2 applicants must submit their application by April 30, 2020, as outlined on the Level 2 webpage. Note there have not been any changes to the prerequisites since last year.

SUMMARY

Subject matter experts and curriculum specialists have been working hard to improve, revise, and update the existing Level 2 curriculum. We're excited to deliver the course and assessment next winter.

If you have any questions relating to applications and registration, please contact Andrea Lustenberger, ITP manager. For questions about the curriculum, please contact Emily Grady, ITP curriculum specialist.

Contributors

PAUL HARWOOD
Paul has spent the last 10 winters with the BC Ministry of Transportation's North Cascades avalanche program based in Hope. Previously, he started his career patrolling at Kicking Horse and did a stint as an apprentice ski guide. This winter he started teaching with the CAA ITP program. In past summers he worked on Gazex and Wyssen Tower installs, but recently paddling and paragliding have taken him away from hard labour.
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SIMON HORTON
Simon is a forecaster with Avalanche Canada and a postdoc researcher at the Simon Fraser University Avalanche Research Program. He completed his PhD studying surface hoar at the University of Calgary's Applied Snow and Avalanche Research Centre and since then has been involved in developing and testing computer models to improve forecasting in data sparse regions like the North Rockies.
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JASON KUMAGAI MSC, CHFP, CCPE, PMP
Jason is the principal human factors consultant at OPTIMAL FiT Inc. based in Calgary. With over 25 years of project experience across a wide range of industry sectors, he specializes in training on alertness strategies and implementing fatigue risk management programs.
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ADAM SHERRIFF
Adam is an avalanche forecaster and mountain safety team lead at Kicking Horse Mountain Resort. He has been living in Golden for 19 years and is a member of Golden and District Search and Rescue and the Canadian Avalanche Rescue Dog Association. When he is not playing in the snow with puppies, he is working with the wild animals of Banff, Yoho and Kootenay National Parks as a resource management officer. He has been an instructor with CARDA for about six years and has been working towards instructing with the CAA.
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ANNE ST. CLAIR
With over a decade working in avalanche education, guiding, and snow safety, Anne has developed broad interests at the intersection of human behavior and natural hazards. As a researcher, she is most interested in the effectiveness of operational risk management practices, education curriculum, and public risk communication products. Anne recently completed a master's degree working with Simon Fraser University's Avalanche Research Program in Vancouver, and is excited to be working as a forecaster at Avalanche Canada this winter.
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THE FUTURE OF AVALANCHE FORECASTING

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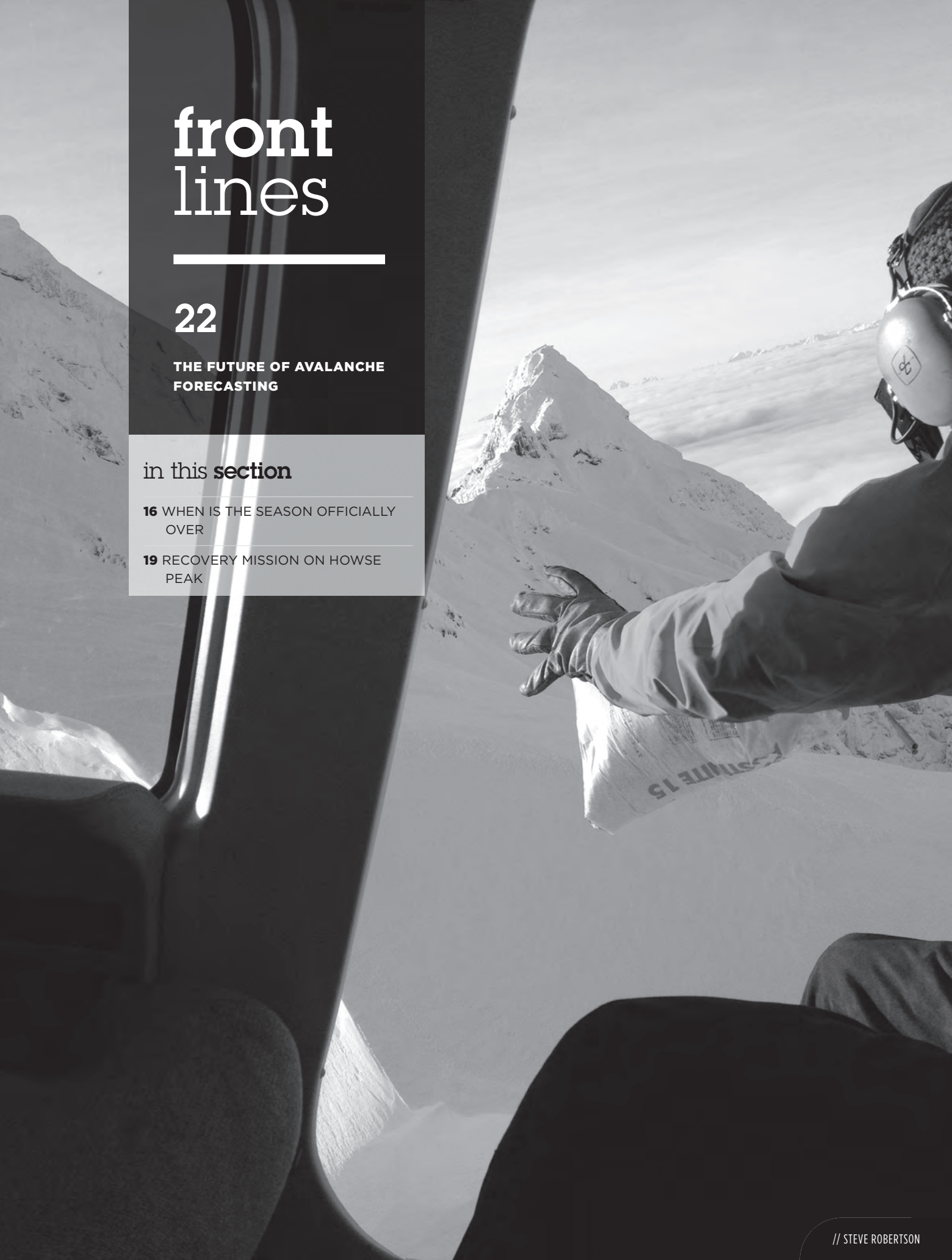


// STEVE ROBERTSON

When is the season **officially over?**

Paul Harwood

When we think about the end of the forecasting season, we can divide avalanche operations and avalanche workers into two groups: those that have a definitive end date, and those that don't.

In heli-skiing, for example, there is a last run of the season. Avalanches continue afterwords, but with nothing at risk, forecasting is no longer necessary.

The second type of operation does not have an end date. These are often industrial operations like mines, railways, highways, and forestry. Some ski areas also have operations occurring in or traveling through avalanche terrain right into summer. In these organizations, forecasters face the delicate task of deciding when avalanches no longer pose a threat to their operation.

As we get further into spring and the snowpack melts, the likelihood of avalanches decreases. Eventually, there is a point where there may still be snow in the start zones, and there may even still be avalanches in the mountains, but there is no longer any operational risk. At this time, you can cease with your risk mitigation measures. Workers no longer need transceivers, signage can come down, and the forecasting program can come to a close. But how do you decide when you have reached this point when exposure to avalanche risk is so low you can call it over?

To answer this question, I interviewed 20-25 forecasters. From those conversations, I compiled some common themes, things they think about, and the techniques they use.

Before diving into it, it's worth discussing why we even have to call the season over. You might be thinking, "Why not just wait a couple of extra weeks after you think it is done to be on the safe side?"

A good tool to understand why it is important we don't wait too long to call the season over is the concept of the operational risk band (Figure 1). At the upper end of the risk band, loss, injury, and possible death demand most of our focus. On avalanche courses and in the workplace, we have developed training, systems, and a safety culture to try and prevent excessive risk.

At the other end of the operational risk band, we have excessive conservatism. Forecasters should aim to function somewhere in the middle. If you wait too long to call the season over, you risk the consequences of being excessively conservative. Although people rarely get killed due to this, the negative outcomes are real.

The most obvious consequence is financial. For example, at a ski hill, once ticket sales have stopped, it becomes a priority to reduce expenditures—and avalanche forecasting costs money. In industrial work, operations are usually ramping up as the snow melts. There are pot holes to patch, trees to harvest, and things to be built. Having to train new staff, provide avalanche rescue gear, and follow operating procedures to reduce the risk of avalanches costs money and can slow production.

Another consequence of being overly conservative is the impact on our reputation as skilled forecasters. This can be subtle, and you may not even be aware when your reputation is being negatively affected. You may face more challenges in getting buy-in to future avalanche forecasts or, worse, it could affect future employment or contracts.

Now that we've looked at the importance of accurately recognizing when the season is over, it's time to get into the

FIG. 1 OPERATIONAL RISK BAND

tips and techniques forecasters use. It is important to note this is just an overview—many of the topics could be articles unto themselves.

MAKE THE PROBLEM SMALLER

Instead of trying to decide when your whole operation is free of avalanche risk, start making this assessment at the level of each individual path or avalanche area. A tool that can be used to accomplish this is making a "run list" of your avalanche paths and then having a rating system. For example, you may have 25 paths of concern during the winter months, but as the melt occurs, you can start removing paths from your list as you feel they no longer pose a substantial risk. The benefit of this approach is you get many opportunities to make the decision. The final call feels a little less daunting when you are only considering your last few paths or the final small area within your operation.

HISTORY

History can be a powerful tool if you're lucky enough to work in an operation with a long historical record. Spring avalanches tend to follow patterns, however, relying on historical records comes with a caveat. It is critical to identify factors that might indicate the season is not going to be business as usual. Be extra suspect with extreme weather or unusual snowpack characteristics. Factors forecasters said they looked for were atypical basal weak layers, above average snowpack years, or a winter where your explosives control efforts did not produce the results and snowpack reduction you would normally see. These can all be indicators you may be more likely to see unusual or larger events than normal.

SNOWPACK

There was a lot of discussion about isothermal snow. In avalanche courses, we often talk about the changes that occur in the snowpack when we have a small or large temperature gradient. We rarely talk about the changes an isothermal snowpack goes through. Even though there is no temperature gradient, isothermal snowpacks undergo significant change over time. Understanding the different stages of isothermal snow can help identify which avalanche problems you may be facing, and how close you are to the end of the season.

1. When a snowpack first goes isothermal, this is often when weak layers wake up.
2. As it warms up further, the snowpack starts becoming punchy and foot penetration increases. This is often when wet slabs start to become active.
3. Next, water starts flowing through the snowpack. This is often the trigger for glide slabs or deep instabilities that have not yet awoken. A notable rise in creeks and rivers may be an indicator you're at this stage in the mountain snowpack melt.
4. As summer approaches, if the slope hasn't avalanched, the snowpack will continue to melt and settle. Eventually you end up with dense summer snow you can walk on. At this point, avalanche activity is unlikely.

AVALANCHE CONTROL

Timing was the most frequent factor of concern in forecasting spring avalanches. I was left with the feeling many forecasters found it harder to nail the timing in spring than in mid-winter. There were countless stories of people going out bombing, getting underwhelming results, and then seeing the same slope released naturally a day later. Other times, forecasters thought the snowpack was not quite ready and decided to wait one more day, only to have an avalanche on the road hours later.

There were some rules of thumb people mentioned about indicators of spring avalanches. The most common two were:

- The well known "first night without an overnight freeze." One thing to note about this generalization is sometimes it takes more time. Although technically the snowpack may be isothermal, often the heat has to percolate into the snowpack for a while before it is prime.
- Another rule of thumb mentioned was "three warm days and three nights with no overnight freeze." One forecaster said he looks for three days of double-digit temperatures.

An exception to these rules of thumb is high north aspects These features can take a surprisingly long time to undergo the changes needed to finally avalanche. The classic example is Path 51 on the Duffey Lake road. Even after heavy Gazex and explosives control, it has produced large avalanches weeks after forecasters first started wondering if it might be done for the season.

Another aspect of control is when results start to gouge down to the ground and your deposits are dirty. This is a good indicator things are nearly done. Dirty deposits greatly increase the melting process, quickly exposing ground roughness and reducing the amount of snow that can be picked up by further avalanche activity.

A great point Johann Slam mentioned is to try to lower explosive placements. Your lower elevation snowpack is usually thinner and the temperatures are warmer, so you may start seeing results while your explosives are still just only making holes in the upper start zones. One benefit of this technique is by taking the legs out of your paths, there may be less mass available when you do start seeing results higher up. Ultimately, this may decrease how far avalanches run and reduce the size of deposits for clean up.

WHEN THIS AVALANCHE RAN IN EARLY MAY, THE TREES WERE ALREADY GREENING UP. // STEVE BRUSHEY

TERRAIN

There was a lot of discussion about terrain. One concept was the idea of "connectivity." As the snowpack shrinks, either through avalanches or melt, start zones can begin to break up and separate. Generally, this is an indicator large avalanches are becoming less likely.

What really stood out when talking about terrain was the focus on the track. How much snow is in the track? Is it isothermal? Could a small avalanche pick up significant mass in the track? Is the track in the shade and frozen solid? Could the frozen track act like a water slide and enable small avalanches to run surprisingly far? When trying to decide how big and how far an avalanche may run, these are some of the considerations forecasters think about.

There was a lot of talk about the shape of the track. Narrow and confined tracks can produce "tooth paste" avalanches, in which the mass from behind just keeps pushing the toe of the debris further and further. There were stories of avalanches initially coming to a stop mid-track, but after a few seconds they moved again and continued travelling to the bottom of the runout. These "tooth paste" avalanches can run hundreds of metres below the snowline, all the way to valley bottom.

FINAL THOUGHTS

Not everything is going to avalanche. Rising temperatures, sun, rain, and explosives—eventually these inputs will stress and modify the snowpack to the point where avalanche activity is either done for the season or at least will not be large enough to reach your elements of concern.

Deciding when the season is over is rarely straightforward. Most people I spoke with used terms like, "It is hard," "It's tricky," and "It's difficult." The best we can do is carefully consider the factors touched on in this article, consult with coworkers and colleagues, and listen to your gut. One of the unique aspects in deciding when the season is over is you may not even know if you made the right call for days or even weeks after you have shut down the forecasting program.

As one person perfectly captured this predicament: "I think there are a lot of forecasters this time of year that feel a little uncomfortable."

Teaching an Old Dog New Tricks
The Recovery Mission on Howse Peak

Adam Sherriff

ADAM SHERRIFF AND HIS CARDA DOG BROOKE PLAYED A KEY ROLE IN THE HOWSE PEAK AVALANCHE RECOVERY MISSION. // TODD KOROL

On April 17, 2019, three of the world's leading alpinists—Jess Roskelley, David Lama, and Hansjörg Auer—successfully summited Howse Peak at the edge of Banff National Park via the incredibly challenging M16 route. Tragically, the three of them were swept away in an avalanche and killed on the descent. A recovery attempt wasn't possible until three days later, on Apr. 20, when the weather cleared enough to allow for a ground search. Canadian Avalanche Rescue Dog Association member Adam Sherriff and his dog Brooke were brought in to aid in the search. This is their story of their part in this challenging recovery mission.

THE HOWSE PEAK ACCIDENT in April 2019 was a tragic event that resulted in a technical and high-profile recovery. As a dog handler, this mission put the years of training I had done with Brooke to the test. Although our part of this large-scale recovery was only 25 minutes long, it was some of the most challenging search conditions I have ever worked a dog in.

Brooke is an 11-year-old German shepherd from the Royal Canadian Mounted Police breeding program. She was raised by an RCMP member in the Lower Mainland before being released from the program and becoming available for purchase. I acquired Brooke in the spring of 2010 when she was just over one year old and immediately got to work with her.

I spent that first summer getting to know Brooke and worked on creating a bond with her. She entered the Canadian Avalanche Rescue Dog Association (CARDA) training program the following fall, and by January 2012 we achieved team-in-training status with CARDA.

We validated as a CARDA dog team in January 2013 and the following spring we achieved our wilderness search validation. Since 2013, we have annually achieved our winter and summer validations. While working and training with Brooke, I completed my *Avalanche Operations Level 2* and became a professional member with the Canadian Avalanche Association, a manager with Golden and District Search and Rescue (GADSAR), and an instructor with CARDA.

Over Brooke's working career, we have responded to many avalanche calls and missing person reports throughout the Kootenays. I began Brooke's helicopter training, including sling training, very early with GADSAR and after just a few rotations, helicopter work was not a stress for her but something she got excited about. The sound of the helicopter landing became a cue for work—and for Brooke work means doing amazing things.

As a team, we were lucky enough to attend a few CARDA advanced training courses. These are designed to push teams

THE SITE OF THE HOWSE PEAK AVALANCHE. // GRANT STATHAM

beyond validation and introduce them to glaciated terrain, rappelling, advanced mountain travel, ski touring, and using alternate modes of travel (snow machine/helicopter) to access rescue sites. Having Brooke sling trained and familiar with working on rope were keys to her success at Howse Peak.

I was contacted by Parks Canada on April 17 requesting my availability to provide avalanche rescue dog support to the rescue team. That first day, I arrived at the highway staging area where I was able to only get an obscured view of the search site. Having trained with the mountain safety team previously, I was confident in my ability to provide support if our services were required. Over the next few days, I sat in on safety meetings and was included in all aspects of the planning leading up to the recovery attempt.

In order to reduce exposure to secondary avalanches, all recovery efforts were to be completed while rescuers were attached to a helicopter long-line. After discussing and working through the logistics of rigging and safety procedures, it was decided that I would work with Brooke on the site while she remained attached to my harness via a 30m line, and I would remain attached to the long-line. This search technique was something I had never attempted with Brooke, but her previous helicopter long-line training and her extensive on-rope search training made this task essentially a combination of previously learned skills put together in a new format. Having Brooke attached to my harness would allow me to control her search patterning, communicate with her through line tension. In the event of a secondary avalanche, it would allow me to extract her quickly from the search site.

As I moved Brooke around the search site, Paul Mahoney, the skilled rescue pilot from Alpine Helicopters, followed in the air. In an attempt to reduce the amount of wind on the search site, we used a 45-metre long-line to increase the distance between the machine and the slope while we worked.

Working under a helicopter while it hovered above us was a new distraction for Brooke. I could see her confusion when we first began to search, as she continued to look back to me for direction and confirmation of her task. Once we settled in, we found our rhythm as a team and began to efficiently cover off large portions of the search site.

Working in those conditions was like searching in a tornado, with constantly changing winds and blowing snow. Brooke's face was quickly covered in snow from continuous helicopter downwash.

My job as the handler quickly became a task of rope management. I had to maintain my line with the helicopter while ensuring Brooke's line remained free of snags, allowing her the range she needed to cover ground. By utilizing her natural desire to range and search, I slowly worked my way downslope and allowed her to cover off 30 metres on each side of me as we searched the debris field. Although I did not communicate with Paul much while we searched, he was an essential part of the success of our mission. He was

in sync with my movements on the ground and made rope management as easy as possible with exceptional flying.

At about 20 minutes into the search, we were nearing a high probability area. Brooke's demeanour and pace quickly picked up and I could see she was in scent. It was so obvious that when Paul received our 20-minute check-in call, he asked for more time as he too could see that Brooke was trying to tell us something. Not long after that conversation, Brooke headed up hill full of determination. I radioed Paul and asked him to lift the weight bag off the ground so we could work back up slope.

As we moved back up, Brooke began pulling out line and was clearly working in a scent cone. She followed the scent to the source and started indicating by digging. She quickly got to work and dug down about 40cm, which exposed some clothing. Once I got to her location, I instantly praised her, placed three crossed wands, and signalled to Paul that we were ready for a lift back to staging. After confirming the location of the climbers, the rescue team returned to the site to begin the digging and recovery process.

Once back at staging, I quickly moved to reward Brooke with a game of ball. She had no idea how big a find she has just accomplished. To her, searching is a game, and that game ends with play.

The Howse peak recovery was essentially a culmination of nine years of working together. It tested our communications system, our trust, and all our training. Some challenges we encountered included trying to cover the whole site with changing winds, communicating with Brooke with constant noise from above, and working through the pressure of such a complex search task.

I also believe it was important to be open to the team leaders about the fact we had never before attempted to search under a helicopter. It allowed us to work as a team to determine the best rigging setup and helped reduce the pressure of trying something new. As dog handlers, we must always remember to "trust your dog," even in the face of great challenges.

I have never been so proud of Brooke as I was while we flew back to staging. During the search she showed confidence and a desire to do work that cannot be taught. Being able to combine all of our individual training sessions into a unique rescue tool was a rewarding success.

ADAM SHERRIFF AND HIS DOG BROOKE ARE LONG-LINED INTO THE HOWSE PEAK AVALANCHE SITE. // GRANT STATHAM

AVALANCHE CANADA FORECASTER GRANT HELGESON TESTS SOME PROTOTYPE FORECASTING TOOLS. // ALEX COOPER

The Future of Avalanche Forecasting

Simon Horton

HOW TECHNOLOGY TRANSFORMED WEATHER FORECASTING, AND WHAT IT COULD DO TO AVALANCHE FORECASTING.

WEATHER FORECASTING HAS RADICALLY transformed over the past century. In the 1920s, field observers reported current weather conditions back to meteorologists, who would draw up weather maps and extrapolate the weather for the next few days. Fast forward 100 years and precise forecasts are possible in mountainous terrain thanks to a global network of earth observations, advances in scientific understanding, and some of the most powerful supercomputers in the world.

This raises the question, will avalanche forecasting head down a similar transition from field-based to computer-based work?

Certainly not anytime soon, but some form of technological progression is inevitable. The transition for weather forecasting took decades, starting around the time of the Second World War. Growth in aviation enhanced our interest in the atmosphere, that in turn changed our perspective of the weather. In the decades that followed, space exploration led to weather satellites that gave us an even broader view of the atmosphere. Then, early computers began crunching numbers to help with these extrapolations.

Despite these technologies, weather forecasting remained deeply rooted in experience-based pattern recognition for several more decades. By the 1970s, computer models began giving reasonable upper air forecasts (such as jet stream forecasts), but the Second World War-era style of human-centric forecasting still prevailed. the tides turned in the 1980s and 1990s when computer forecasts became more accurate and forecasters eventually learned when they could and could not trust them. Trust in the ability of computer models to accurately predict weather continues to grow.

Avalanche forecasting currently relies on manual field observations and experience-based pattern recognition comparable to methods used by Second World War-era weather forecasters. However, over the past decades, the avalanche research community has developed remote sensing and computer modelling methods that have similar potential to observe, understand, and predict avalanche conditions. These technologies are at a similar status to weather forecasting technologies from the 1960s or 1970s. New methods are becoming available, but we don't really know how to implement them into daily work.

As we saw in weather forecasting, these barriers were eventually overcome as the technology improved. We can speculate what a future avalanche forecasting system might look like by looking at how similar technology transformed weather prediction.

OBSERVATIONS AND PREDICTIONS

Modern weather forecasters use interactive dashboards that combine field observations, satellite imagery, and computer predictions to form a comprehensive picture of current and future weather conditions. Could this be what our workspaces look like in the future? Maybe instead of simply reviewing field observations from your own and neighbouring operations, a future avalanche forecasting tool will combine these observations with automated maps of avalanche activity, virtual snow profiles, and computer predictions of future conditions. to help form a more comprehensive picture of avalanche hazard. Even if it's speculation, it's important to understand the potential for technology to change avalanche work so we can shape it in a way that we all benefit.

The technologies impacting weather and avalanche forecasting broadly fit into two categories: ones that observe the conditions and ones that predict the conditions. In terms of observing conditions, weather satellites were the game changer that allowed us to expand from point observations to continuous spatial coverage. The same thing could happen with avalanche and snowpack observations. Networks of detectors that sense vibrations from avalanches are already installed, and recent research out of Europe has shown impressive accuracy in detecting avalanche debris in near real-time using radar-based satellites. Testing in Norway has found these satellites, which can even see through clouds, can provide updated daily maps of avalanche debris with complete spatial coverage across mountainous terrain. Imagine being able to see map of every avalanche that ran in Canada over the past 24 hours!

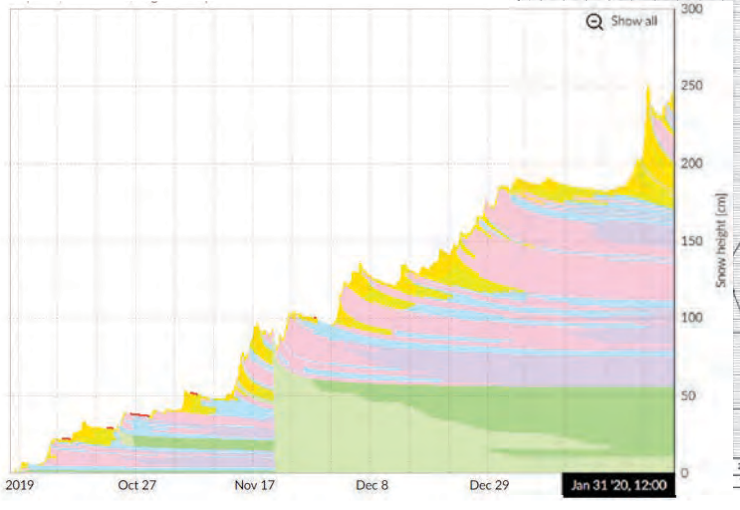
Remote sensors—from either satellites, aircrafts, drones, or on the ground—can also tell us about the snowpack. Deriving maps of snow-covered areas is already straightforward, but there is an increasing ability to sense snowpack layering remotely too. There are still many hurdles to getting actual x-ray vision into the snowpack—detecting thin weak layers is difficult, wet snow and crusts create a lot of errors, and all remote sensing technologies struggle in steep complex terrain. Advances in remote sensing are happening quickly, but most likely will need to be supplemented with other information to give us the best possible picture of avalanche conditions.

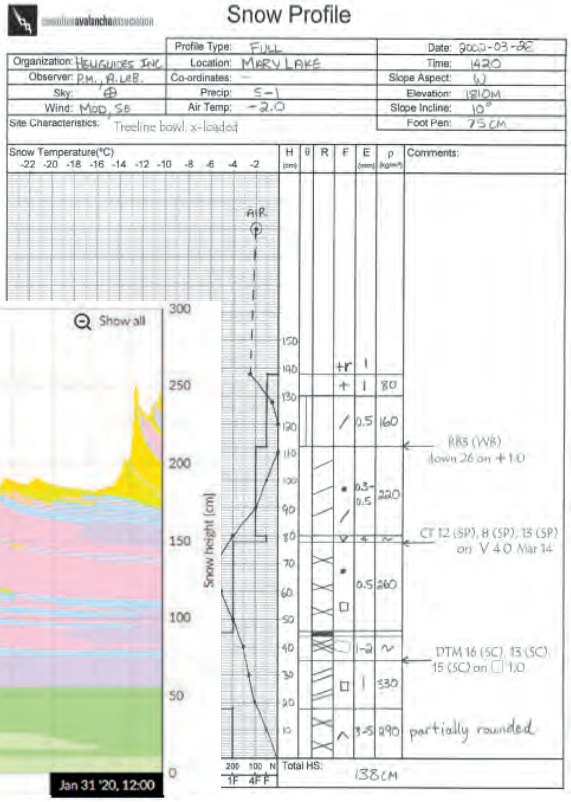
This is where prediction comes in. Our understanding of weather evolved in the 1920s with improved theories about the 3D structure of frontal systems. This didn't have much impact on forecasting until several decades later when these theories were applied in computer models. This has become the backbone of modern weather forecasting.

Similar advances in snow science over the past decades have enhanced our understanding of how weak layers form, how avalanches release, and how they move downslope. The latest theories about snow microstructure and fracture mechanics are being implemented into computer models that simulate both the evolution of the snowpack structure as well as the movement of avalanches once they release. Could these models eventually have as much predictive power as weather models?

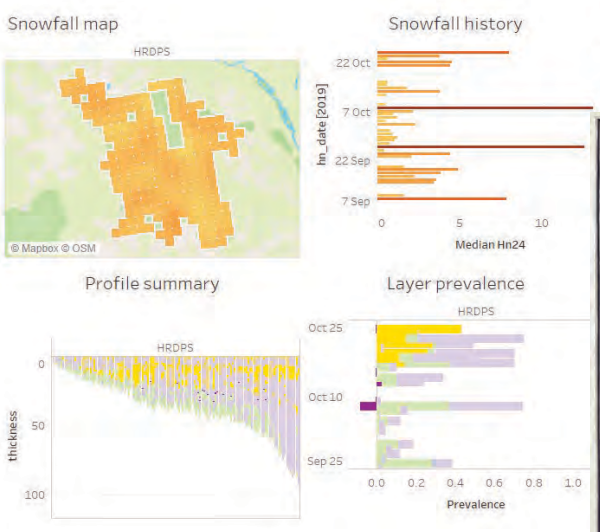
VIRTUAL SNOW PROFILES

One promising forecasting application is computer models that simulate snow profiles with weather and terrain data. Some European countries started testing virtual snow profiles in the 1990s and Avalanche Canada started testing similar products 10 years ago with a focus on remote, data-sparse areas where the models could be driven with weather forecasts. (You may have seen these virtual profiles on ARFI.) Since their inception, the consistent question is, "How accurate are they?"

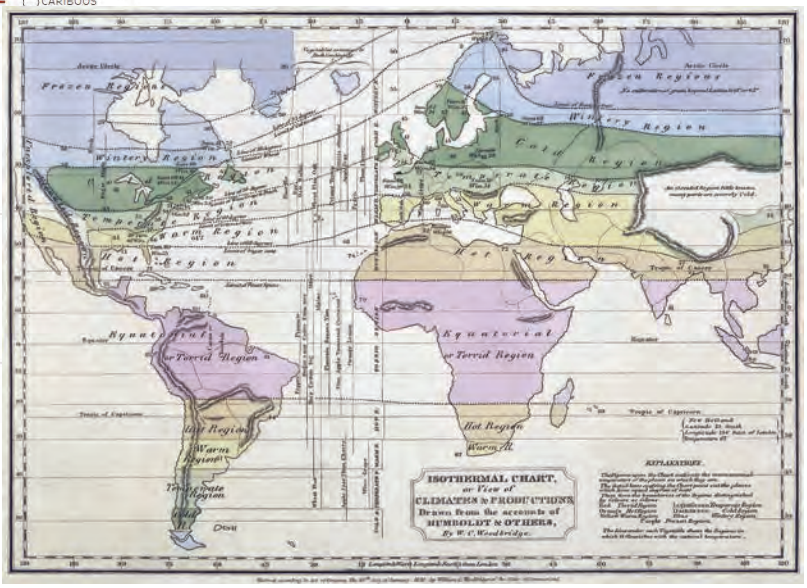




A VIRTUAL SNOW PROFILE CONTRASTED WITH A HAND DRAWN ONE // SIMON HORTON



LEFT: A SATELLITE IMAGE OF WESTERN NORTH AMERICA FROM ????? RIGHT: AN ISOTHERMAL CHART OF THE WORLD CREATED 1823 BY WILLIAM CHANNING WOODBRIDGE USING THE WORK OF ALEXANDER VON HUMBOLDT. // WIKIPEDIA CREATIVE COMMONS



After 10 years of developing and testing these models for public forecasting in Canada, our impression is they provide a reasonable picture of general snowpack patterns, at least at some of the locations some of the time. Similar to how early weather models provided semi-realistic jet stream forecasts, the latest snowpack models can provide some big picture context to what is happening in the snowpack.

Weather models started being useful for big scale processes and we can expect snowpack models to follow suit. Rather than treating virtual profiles as slope-specific information, we can use snowpack models to look at regional differences in snowpack structure. For example, a surface hoar layer may form in the northern Monashees but not the southern Monashees because a storm tracking along the U.S. border causes too much cloud cover for surface hoar to form. Current applications of virtual snow profiles can already resolve some of these big-scale patterns. A focus of the avalanche research group at Simon Fraser University is developing ways practitioners can visualize and understand these patterns.

Weather models eventually grew from basic advisory tools to predictive powerhouses. A big reason they became more accurate in the 1980s and 1990s is they were fed with more observations of current atmospheric conditions. Uncertainties about the current weather (such as the initial conditions) is one of the main sources of errors in weather models. Over the past few decades, the amount of observations that could be collected by satellites, radars, and airborne sensors has exploded. Once the initial weather conditions are processed, computer models simply apply the laws of physics to figure out what will most likely happen next.

Similarly, the biggest source of uncertainty in snowpack models is figuring out when, where, and how much it snows. The most realistic virtual snow profiles are the ones at locations with good snowfall measurements or forecasts. Once snow is on the ground, the laws of physics do a pretty good job of figuring out how it evolves, but measuring and predicting snowfall is still hard, and even the best measurements and models currently fall short. We can expect to continue getting better at knowing how much it snows with better weather forecasts and observation networks. From there, we can get better at predicting the snowpack structure.

MERGING OLD AND NEW

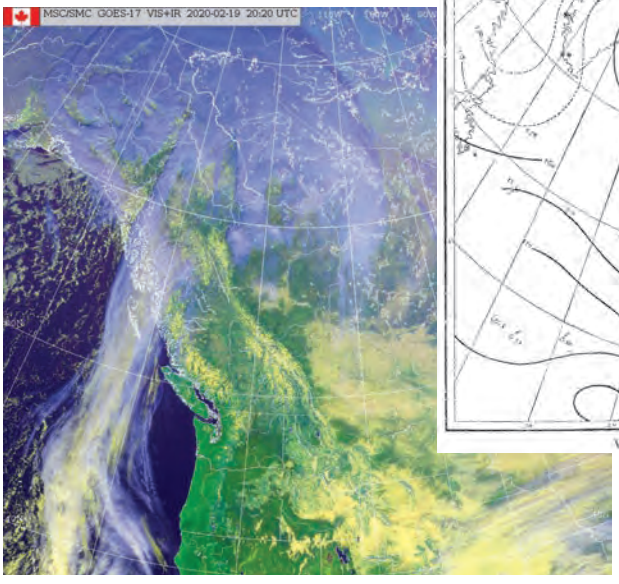
Early weather models were considered advisory tools. Meteorologists would check their own jet stream forecasts against the computer forecasts to increase confidence in their predictions. Computer-based systems were brought into the loop to augment human capabilities rather than replace them. They were a thinking tool. What really changed the day-to-day operations of meteorologists was the development of tools that merged old methods with the new technology.

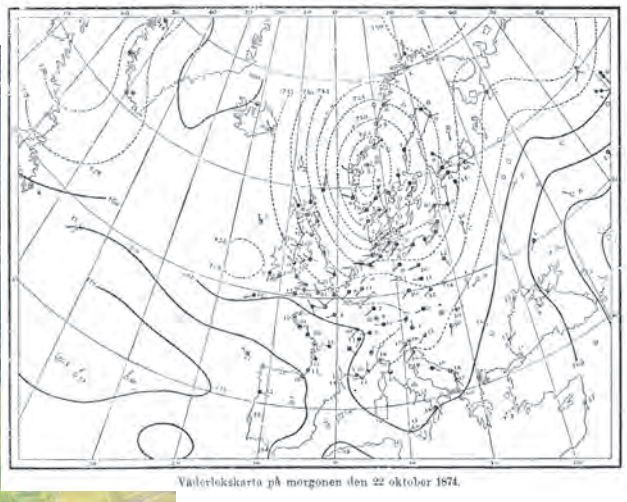
In the late 1990s, interactive computer dashboards were developed that allowed forecasters to visualize field observations, satellite imagery, and computer model forecasts all in one place. Bringing different sources of information together allowed forecasters to get the most complete picture, filter through all the information, and weight each type of data according to its strengths and weaknesses.

The InfoEx is a current example of a forecasting tool that helps us build an understanding of avalanche conditions based on field observations and analysis by fellow professionals. Perhaps a future version of the InfoEx could combine the information we currently use with satellite maps of avalanche debris and some fusion of a remotely-sensed and computer-simulated snowpack visualizations to give us a more complete picture of avalanche conditions. If designed effectively, such a tool should help us assess hazards faster, more efficiently, and more accurately.

There's lots of talk about machine learning and losing

work to automation. This is scary for a community that looks to the mountains for an escape from the chaos of the digitized world. These emerging technologies could change aspects of avalanche work, but they won't automate it. The transformation of weather forecasting took decades, billions of dollars, and major international collaborations. Even with that, weather is (probably) still easier to predict than the delicate slope-scale processes that cause avalanches. Plus, meteorologists still have jobs—they just spend less time analyzing data and more time communicating and making decisions.




Väderlekskarta på morgonen den 22 oktober 1874.

LEFT: METEROLOGY SERVICES OF CANADA RADAR IMAGE OF WESTERN CANADA // MSC RIGHT: WEATHER MAP FROM SCANDINAVIA FROM 1874 // WIKIPEDIA CREATIVE COMMONS

The hope is that integrating new technologies will improve our hazard assessments so we can focus our time and energy on risk mitigation. Computers are great at pattern recognition—better than humans in many fields—but thankfully avalanche forecasting is more than that. Computer predictions will need to be verified, interrogated, and interpreted by humans. Ultimately, the complex mitigation decisions are up to us. Field work may become more targeted, where the computer system identifies the greatest uncertainties that need to be resolved by sending field teams to answer specific questions.

There will certainly be a learning curve, perhaps a slow one, where we gradually learn what technology can offer. We should all be engaged to learn about how these technologies work and, more importantly, have our say on how they should be implemented so we can make informed decisions about the future of avalanche forecasting.

REFERENCES

Benjamin, S. G., Brown, J. M., Brunet, G., Lynch, P., Saito, K., and Schlatter, T. W., 2019. 100 years of progress in forecasting and NWP applications, Meteorological Monographs, 59, 13.11-13.67.

Eckerstorfer, M., Bühler, Y., Frauenfelder, R., and Malnes, E., 2016. Remote sensing of snow avalanches: Recent advances, potential, and limitations, Cold Regions Science and Technology, 121, 126-140.

Horton, S., Nowak, S., and Haegeli, P., in review. Enhancing the operational value of snowpack models with visualization design principles, Natural Hazards and Earth System Sciences.

Morin, S., Horton, S., Techel, F., Bavay, M., Coléou, C., Fierz, C., Gobiet, A., Hagenmuller, P., Lafaysse, M., and Ližar, M., 2019. Application of physical snowpack models in support of operational avalanche hazard forecasting: A status report on current implementations and prospects for the future, Cold Regions Science and Technology, 102910.

	STATUS OF WEATHER FORECASTING	PARALLELS TO AVALANCHE FORECASTING
ERA 1 (1919-39)	EMPIRICAL FORECASTING, SURFACE OBSERVATIONS, EXTRAPOLATING PATTERNS ON SURFACE WEATHER MAPS	PAST AND PRESENT: MANUAL FIELD OBSERVATIONS, WEATHER FORECASTS, INFERRING PATTERNS USING A CONCEPTUAL MODEL OF AVALANCHE HAZARD
ERA 2 (1939-56)	MILITARY FOCUS, UPPER-LEVEL CHARTS DERIVED FROM WEATHER BALLOONS AND AVIATION	
ERA 3 (1956-85)	INFER SURFACE CONDITIONS FROM SATELLITE IMAGERY AND COMPUTER MODEL FORECASTS OF UPPER-LEVEL FLOW	NEAR FUTURE: INFER AVALANCHE CONDITIONS FROM SNOWPACK MODELS, REMOTE SENSING OF AVALANCHE DEBRIS AND SNOWPACK LAYERS (AND FIELD OBSERVATIONS)
ERA 4 (1985-NOW)	INCREASED ADOPTION OF COMPUTER MODEL FORECASTS, GLOBAL EARTH OBSERVATION NETWORK, SHIFT TO COMMUNICATION AND DECISION-MAKING	DISTANT FUTURE: SHIFT TO COMMUNICATION AND DECISION MAKING?

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28

GETTING TO KNOW THE RECREATIONAL AUDIENCE

in this **section**

// LISA DRIER

HENRY FINN, A MASTERS STUDENT IN THE AVALANCHE RESEARCH PROGRAM AT SIMON FRASER UNIVERSITY, INTERVIEWS A STUDENT ABOUT AVALANCHE FORECASTS USING THE ORTOVOX SAM MOUNTAIN MODEL. // ANNE ST. CLAIR

How Getting to Know the Recreational Audience Can Improve the Effectiveness of the Avalanche Bulletin

Anne St. Clair, Henry Finn, Pascal Haegeli, Karl Klassen, and Robin Gregory

SELF-DIRECTED WINTER BACKCOUNTRY RECREATION in avalanche terrain presents a particularly challenging public safety issue. This is because recreationists voluntarily go into the mountains, where there are few mandated closures, and where they are responsible for their own avalanche risk management.

The fact 90% of avalanche fatalities in Canada involve self-directed recreationists clearly highlights this challenge. To help them plan for safe backcountry travel, avalanche warning services around the world publish avalanche bulletins with detailed information about avalanche conditions. To be most effective, the bulletin must excel in two capacities: it needs to provide consistent, unbiased, and accurate information; and it needs to deliver information in a way that can be understood by the audience.

However, the recreational audience varies widely when it comes to their knowledge, skills, and experience managing avalanche risk. With the rapid growth in backcountry recreation, this range in comprehension continues to expand. It means recreationists interpret bulletin information in different ways. To make it the most effective for the broadest audience, it's important that we understand and address these differences.

Our industry has made significant advances to improve the accuracy and consistency of forecasts, including developments such as the North American Public Avalanche Danger Scale (Statham et al., 2010) and the Conceptual Model of Avalanche Hazard (Statham et al., 2018). However, we have yet to explicitly examine how recreationists use bulletins. Because best practice in risk communication emphasizes the importance of knowing our audience (Fischhoff, 1995), our research objective was to get to know the recreational audience in a way that went beyond demographics or activity type, and that allows us to see them in terms of how they use the bulletin. We explicitly examined how recreationists find, interpret, and incorporate bulletin information into

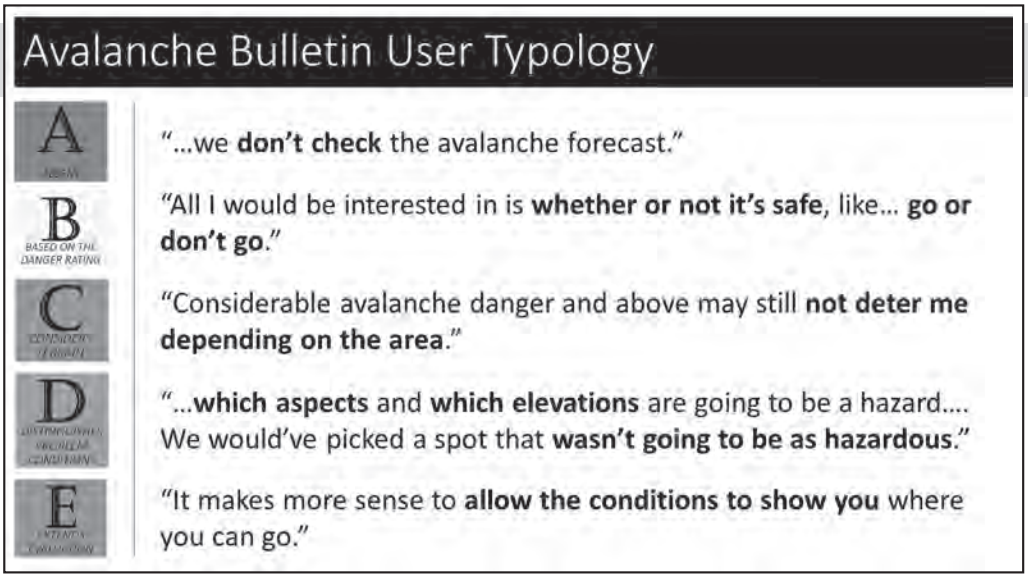

FIG. 1 THE AVALANCHE BULLETING USER TYPOLOGY

their avalanche risk management practices. This allowed us to identify patterns in bulletin-use behaviour that can be classified into a bulletin user typology.

We conducted 46 individual, qualitative interviews with backcountry recreationists in Vancouver, Squamish, and Whistler. We focused our recruitment efforts on capturing the full range of the recreational community. The resulting sample included recreationists who participate in a variety of activities, including mountain snowmobiling, snowshoeing, ice climbing, and backcountry skiing and snowboarding.

We also made a concerted effort to include the harder to reach entry-level backcountry users. We had 14 participants with no formal avalanche training, and participants reporting never or rarely using the bulletin. To identify patterns in the interview data and to establish a classification system, we conducted an applied thematic analysis supported by a series of quantitative analyses.

We strategically ordered the interview script into sections that included background information, a discussion of participants' planning processes, and an outline of participants' information sources and their role in travel decisions. We conducted these interview sections prior to mentioning the avalanche bulletin so as not to bias responses. We then engaged in an in-depth review of avalanche bulletin information in which we had participants detail how they use the information. This part of the interview was followed by a series of application exercises, one of which asked participants to identify the problem areas on a 3D mountain model given the forecasted information. We concluded with a discussion of how social factors influence their bulletin use.

AVALANCHE BULLETIN USER TYPOLOGY

The resulting Avalanche Bulletin User Typology reveals a five-class hierarchy with a clear progression in the depth of bulletin use, the degree of comprehension, and the extent of information application (Figure 1). The classes are labeled Type A, B, C, D, and E and are detailed as follows:

Type A stands for **"Absent"** as these recreationists do not consult the bulletin. They may intercept bulletin information from other channels such as the media, trailhead signage, or social networks. They had different reasons for not using the bulletin. They may lack awareness the product exists, or they may not consider the information relevant to where they travel or to their activity type.

Type B stands for **"Based on the Danger Rating"** as these recreationists make a go or no-go decision dictated by the rating. They expressed difficultly making this type of binary decision with the ratings in the middle of the scale, especially for considerable danger. Additionally, they found the bulletin information beyond the danger rating difficult to understand. Because they pre-determine their safety, these users are not making observations related to their terrain exposure or to avalanche hazard while travelling. Instead, they rely primarily on marked trails, peer recommendations, and online resources to guide their risk management decisions.

Type C stands for **"Considers Terrain."** These users also primarily use the danger rating, but they combine it with a consideration of avalanche terrain exposure to decide where to travel. Using the danger rating as a threshold, they determine whether travel in avalanche terrain is appropriate. They describe their field assessments as focused on terrain identification. Like Type B users, they too find incorporating avalanche problem information a challenge. They either simply avoid situations that require its application, or they commonly defer to more experienced partners to make risk management decisions for them.

Type D stands for **"Distinguishes Avalanche Problem Conditions."** These recreationists integrate the avalanche problems into a complete risk management strategy that accounts for hazard and exposure by applying the information to open and closed terrain appropriate for travel. They generally understand the implications of the avalanche problems for risk mitigation strategies; however, they may not accurately recognize or assess the hazard conditions in the field. Therefore, they place greater weight

on their pre-determined terrain closures than on their field assessments. In general, they express a lack of confidence in their interpretations.

Type E stands for **"Extends Evaluation."** These recreationists extend their assessment of bulletin information to where they are travelling. They use the bulletin as a starting point to inform their continuous assessment of avalanche hazard, which is how it is intended to be used. They are capable of recognizing conditions differently from what was forecasted. They engage in a detailed review of bulletin information to find the supporting evidence behind the information icons.

The resulting Avalanche Bulletin User Typology consists of defined, ordered stages that build on each other and meet the criteria to operate as a stage theory. Stage theorists suggest we develop explanations for each stage transition to address specific barriers to advancement (McCammon, Haegeli, & Gunn, 2010).

Interestingly, we discovered an interdisciplinary link to the field of education in Biggs and Collis' (1982) Structure of Observed Learning Outcomes taxonomy (SOLO) that offers an explanatory framework for the stage transition criteria. The SOLO taxonomy is a well-established hierarchy of learning quality that precisely parallels the Avalanche Bulletin User Typology, whereby learners may miss the point (Type A), identify one relevant aspect (Type B), combine several relevant aspects (Type C), recognize a system and its integrated parts (Type D), or extend the subject into a new dimension (Type E) (Figure 2).

Most importantly, the SOLO taxonomy defines the two main changes that mark stage transitions to address the barriers to advancement. The first three stages require a quantitative increase in knowledge, and the latter two stages require a qualitative, conceptual restructuring to deepen understanding.

Linking the Avalanche Bulletin User Typology with the SOLO taxonomy defines the stages of bulletin information use. It details the product challenges for users in different stages, and outlines the explicit barriers to advancement. This allows us to see our audience in terms of how to reach them with risk communication products. From there, we can consider improving the bulletin's effectiveness in two ways.

First, we can consider how well our products resonate with recreationists at specific stages. For example, given that type B and C users are most dependent on the effectiveness of the danger rating, we can now evaluate and improve the product in the context of their decision processes. Secondly, we can consider the bulletin's capacity to target and facilitate stage transitions to help recreationists advance to higher-level information outcomes.

Interestingly, in their suggestions for improvement, participants made requests that align with their corresponding transition criteria. For example, those making a transition requiring a deepened conceptual understanding (Type C, D, and E users) requested interactive exercises offering feedback as to whether they were interpreting the information correctly. This is important to reflect upon given the backcountry's "wicked learning environment," where recreationists have few corrective feedback opportunities from which to learn (Hogarth, 2001).

The results of this study suggest that for the bulletin to reach its full potential, we need to re-envision it as an educational tool, not just a conditions report. Thinking in this way will require re-framing the bulletin within the

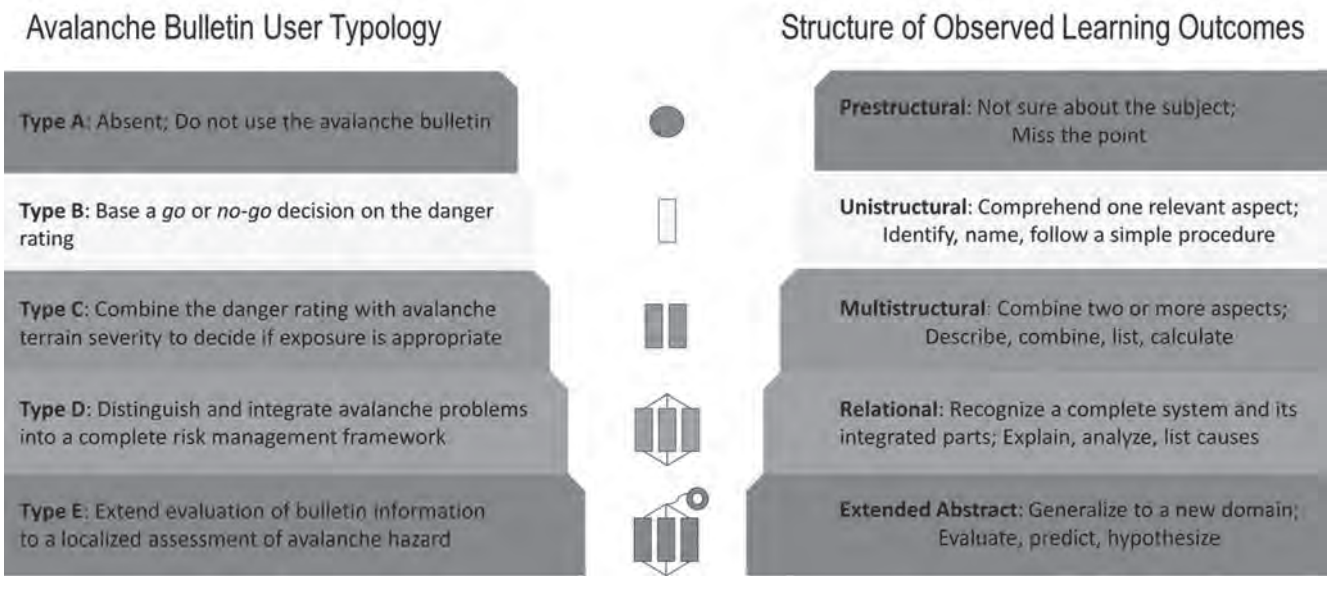

FIG. 2 THE LINK BETWEEN THE AVALANCHE BULLETIN USER TYPOLOGY AND THE SOLO TAXONOMY (BIGGS & COLLIS, 1982).

broader avalanche education system and in the context of other products and programs such as social media outreach, awareness initiatives, and formal avalanche education curriculum.

Due to its central role as a provider of up-to-date avalanche information, the bulletin is uniquely positioned to reach and engage a wide-ranging audience on a routine basis. The Avalanche Bulletin User Typology provides a critical stepping stone for identifying which programs and products are best to provide recreationists with the information they need for decision-making at their particular stage. It can also help advance them to become more proficient avalanche bulletin users most effectively.

Interested readers can access the thesis publication at www.avalancheresearch.ca/pubs/2019_stclair_bulletinusertypology.

REFERENCES

Biggs, J. B., & Collis, K. F. (1982). *Evaluating the quality of learning: The SOLO taxonomy*. New York, NY, US: Academic Press.

Biggs, J. (n.d.). SOLO taxonomy. http://www.johnbiggs.com.au/academic/solo-taxonomy/

Fischhoff, B. (1995). Risk perception and communication unplugged: twenty years of process. Risk Analysis, 15 2, 137-45. https://www.cmu.edu/epp/people/faculty/research/Fischhoff-RAUnplugged-RA.pdf

Hogarth, R. M. (2001). *Educating Intuition.* Chicago, IL, US: University of Chicago Press.

McCammon, I., Haegeli, P., & Gunn, M. (2008). Out-of-bounds avalanche awareness: Assessment, current practices, and future management. *Proceedings of the International Snow Science Workshop*, Whistler, BC, Canada. http://arc.lib.montana.edu/snow-science/item/76

Statham, G., Haegeli, P., Greene, E., Birkeland, K., Israelson, C., Tremper, B., & Kelly, J. (2018). A conceptual model of avalanche hazard. *Natural Hazards*, 90(2), 663–691. https://doi.org/10.1007/s11069-017-3070-5

Statham, G., Haegeli, P., Birkeland, K. W., Greene, E., Israelson, C., Tremper, B., & Kelly, J. (2010). The North American Public Avalanche Danger Scale. *Proceedings of the International Snow Science Workshop*, Squaw Valley, CA, USA. http://arc.lib.montana.edu/snow-science/objects/ISSW_O-020.pdf

// CURTIS PAWLIUK

Indefatigable? Fatigue Risk Management in Wilderness Ski Guiding

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THE WILDERNESS SKI GUIDING community has a growing appreciation of human error and poor decisions that can be associated with fatigue. Previous articles in *The Avalanche Journal* have introduced the topic of fatigue, along with other human factors, as "a common culprit leading to human error."[2] Worker fatigue was a potential contributing factor in a 2016 blasting incident where "the operation did acknowledge high output from all its team members for extended periods at the time of the incident."[3]

Over the summer of 2019, an industry review was commissioned to help characterize the fatigue that wilderness ski guides are exposed to throughout their workdays and season. It was conducted by Optimal Fit Inc., a Canadian consulting firm that specializes in fatigue risk management and human factors, on behalf of HeliCat Canada. The project was also supported by the Association of Canadian Mountain Guides, the Canadian Avalanche Association, and the Canadian Ski Guide Association. Funding for the project was provided by WorkSafeBC.

INTRODUCTION

The ski guiding workforce works hard over the course of a relatively short and intense season, ramping up in November and down again in May. Over the course of the season, guides work many consecutive long days that can be both physically and mentally demanding. Tasks include safety-critical elements given that duties include safety and risk management in remote, avalanche prone locations.

Fatigue can lead to impaired judgement and increased risk taking behaviour, which may introduce additional risks given that guides are responsible for overall mountain and avalanche risk management, and important decisions regarding the safety of themselves, co-workers, and guests. The goals of this study was to identify fatigue-related risk factors in the wilderness ski guiding industry and identify what actions can be taken to manage and control fatigue-related risks.

METHODOLOGY

Data was collected through an online survey titled, "Work and Fatigue Survey – Wilderness Ski Guiding." It was completed by 265 respondents in British Columbia and Alberta. Interviews were also conducted with a representative sample of business managers and owners to identify policies, procedures, tools, and initiatives used to address fatigue as a workplace hazard. Discussions with industry stakeholders were used to detail the potential factors that can contribute to fatigue-related risks in the wilderness skiing industry.

DEMOGRAPHICS

The surveys and interviews included respondents from helicopter skiing, snowcat skiing, and ski touring businesses. Respondents ranged in age from 18–74 years old, with 37% between the ages of 35–44. They had a wide range of experience, from less than two years to more than 20 years in the industry. About one third of respondents had more than 20 years of experience, and 31% were lead guides.

PREVALENCE AND IMPACT OF FATIGUE

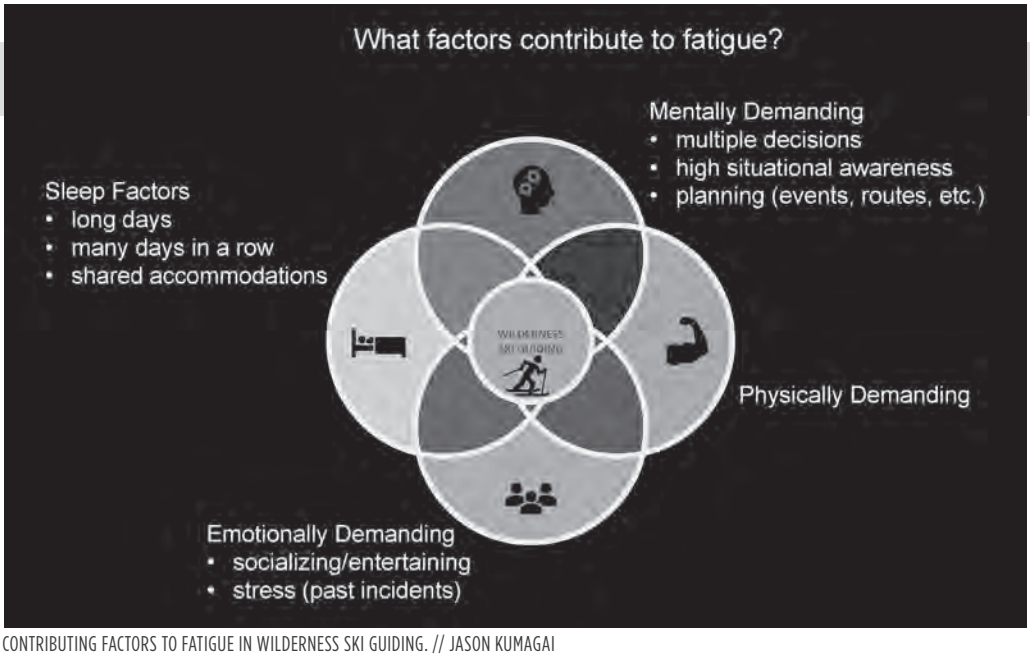
A significant majority (79%) of respondents reported they believed the prevalence of fatigue is "high" or "very high" in the wilderness ski guiding industry. While this suggests fatigue is widespread, only three percent of respondents felt fatigue reaches "severe" levels at work. More than half (52%) rated the typical fatigue levels at work as "moderate."

The perceived impacts of fatigue on performance included:

- More conservative decision making
- Reduced mental focus and attention
- Increased forgetfulness
- Less likely to perform non-essential activities
- More likely to follow existing tracks
- More worried about getting injured
- Less client engagement

COMMUTING AND DROWSY DRIVING

Because of the remote working locations, guides can drive long distances to and from work at the start and end of their rotations. More than half of respondents (63%) had commuted more than two hours. A majority (58%) indicated they had driven while drowsy to a point of being unsafe. Approximately one-third of respondents (35%) reported they had been involved in a motor vehicle accident or close call while driving to or from work. These responses suggest a significant exposure to accident risk related to drowsy driving to or from work.



CONTRIBUTING FACTORS TO FATIGUE IN WILDERNESS SKI GUIDING. // JASON KUMAGAI

CAUSES OF FATIGUE

There are multiple factors contributing to fatigue. Most respondents (38%) indicated scheduling was the main cause. Commonly starting their day at 6 a.m. and ending after dinner with clients around 7 p.m., more than half (55%) worked more than 12 hour days. On average, respondents indicated they worked 13.4 hours per day. Additionally, respondents indicated the most days worked in a row was 18 consecutive days on average.

Both mental demands and physical demands were rated as "high," "very high," or "extremely high" by a significant majority (87%) of respondents. High emotional/social demands were believed to be a main cause of fatigue by five percent of respondents. A significant portion (31%) indicated the requirements to have dinner and socialize with clients "almost always" or "frequently" impacted their quality or quantity of sleep. One-quarter indicated work sleeping quarters did not support conditions for quality sleep. Respondents commented on poor sleeping environments resulted from shared rooms, noisy guests or roommates, and uncomfortable mattresses.

Personal sleep hygiene and habits may also contribute to fatigue. One-quarter considered alcohol or medications as sleep aids, which may mean they don't recognize the contributions alcohol and medications can have on poor sleep quality and quantity. Results suggested there may be some undiagnosed sleep disorders that can contribute to poor sleep. As well, 87% indicated they "never" or "rarely" napped during a workday, reinforcing the importance of adequate sleep at night.

DEFENCES AGAINST FATIGUE

Fatigue is prevalent in the wilderness ski guiding industry, however, the results suggest that for the most part it is not at a severe level. Only eight percent felt fatigue "frequently" or "almost always" interfered with decision-making, risk assessment, or the overall quality of their work or service. A unique aspect of the industry is the high demands are well managed through existing controls in the system.

Although schedules include long workdays and extended consecutive workdays, workers were provided enough sleep opportunity to get the recommended seven to nine hours of sleep each night. Schedules avoided night work and had extended breaks (four to seven days) between work rotations, which helped provide sufficient recovery time. Work schedules also promoted healthy sleep habits, including a regular sleep schedule, good sleep environments with low noise and light, healthy diet, exercise, and daylight exposure. Consecutive workdays have the added benefit of helping guides maintain awareness of the ski conditions to stay in the "rhythm and routine" of guiding.

Physical demands were high, yet a significant majority (84%) of respondents indicated they were "very healthy" or "extremely healthy." Mental demands were mitigated through well-established training on risk assessment and safety. Well-structured briefing sessions, communications, and regular analysis of conditions helped with the execution of well-established processes that contribute to high service and safety. The team dynamic also helped to share the mental workload with other guides.

Emotional and social demands were mitigated with breaks and free time that provided time to get away from work and social responsibilities to decompress mentally and emotionally. Many respondents indicated the option to skip dinner and evening social responsibilities with clients helped provide additional recovery.

PERSONAL SLEEP HYGIENE AND HABITS

About half of respondents (51%) felt they were "very" or "extremely" effective in managing fatigue-related risks at work. Less than 10% indicated they never or rarely got enough sleep prior to work or had difficulty falling asleep. There is good adoption of alertness strategies such as nutrition, exercise, stretching, meditation, and hydration. There does not appear to be an over-reliance on caffeine as an alertness strategy, with only 13% ingesting more than the recommended limit.

Education may help improve the quality and quantity of sleep by clarifying the impact of alcohol, medications, naps, and sleep disorders.

Business owners indicated efforts have been made to optimize staff accommodations. While space limitations prevent the assignment of private rooms in some cases, efforts are made to respond to concerns voiced about accommodations. Education on sleep hygiene techniques, such as night masks and ear plugs, may be considered to help workers overcome environmental limitations.

ORGANIZATIONAL FATIGUE RISK MANAGEMENT

As a positive sign that fatigue is on the radar of companies is that a significant majority of respondents (81%) believed fatigue is an important safety issue to their employer. However, 75% also indicated they had not received training or education about fatigue from their employer. One in four respondents indicated they did not feel comfortable telling management or leadership if they were too tired to perform their job safely.

IMPROVING FATIGUE RISK MANAGEMENT

Opportunities for improved fatigue risk management are available. Options include:

- Provide education and training on fatigue.
- Plan schedules to limit consecutive days worked.
- Integrate screening for sleep disorders.
- Integrate fatigue hazard identification in daily meetings and debriefs.
- Optimize accommodations for sleep.
- Establish a procedure for napping.
- Provide options to prevent drowsy driving.
- Integrate processes to investigate for fatigue in incidents.
- Provide relief from requirements for evening duties, such dinner and socialization.
- Establish a fatigue risk management policy or program.

NEXT STEPS

Preliminary results of the study were presented at the HeliCat Canada AGM, and at the CAA and ACMG continuing professional development session in the fall of 2019. The information was positively received, with a great deal of interest in the findings. Feedback from attendees suggested a desire for stakeholders to share the findings and consider the opportunities for improved fatigue risk management.

A final report was issued to HeliCat Canada that included a Fatigue Risk Management Assessment Tool that may be used by businesses to self-assess their tactical and strategic activities. Another proposed next step was to establish an industry-wide fatigue risk management advisory committee to help promote an industry culture that effectively recognizes and mitigates fatigue-related risks.

ACKNOWLEDGEMENTS

I would like to acknowledge and thank all the respondents and interviewees for their time and thoughts. I would also like to thank Ian Tomm for assisting with coordinating the study and providing insight into the ski guiding community.

READY TO ADDRESS FATIGUE?

For customized training sessions, or for assistance completing the Fatigue Risk Management Assessment Tool, please contact Jason Kumagai at jason@optimalfit.ca

REFERENCES

1. Kumagai, Jason. (2020) Fatigue Risk Management in Wilderness Ski Guiding. Report submitted to HeliCat Canada Association.
2. Inniss, Mike. (2017) We Are Only Human After All: Human Factors in Mountain Rescue. The Avalanche Journal, Vol. 114, pp. 34-36.
3. Brushey. Steve. (2017) Fuse News: Explosives Committee Update. The Avalanche Journal, Vol 115, pp. 20-21.

FIVE TIPS TO **IMPROVE YOUR SLEEP**

1 Activities out in the mountains will help you get exercise and exposure to natural light during the day, both of which help to promote good quality sleep.

2 Stay hydrated with approximately six to eight glasses (1.5 litres) of water a day. Dehydration can cause your blood pressure to drop which can reduce blood flow to the brain and make you feel tired. It can also make it harder for you to stay asleep. Drink even more water at high altitudes because the lower humidity can cause you to lose greater amounts of water through sweat and respiration.

3 Alcohol may help you fall asleep faster, but too much can interfere with your sleep cycles. Because alcohol is a diuretic, it can also contribute to dehydration and may cause you to wake up at night to go to the washroom.

4 Avoid the use of light emanating electronic devices in the last hour before bed. The blue wavelengths of light can suppress the production of melatonin, your body's hormone that helps to induce sleep.

5 Optimize your sleep environment with a cool temperature (16°C to 20°C) and minimal lights. Eye shades, ear plugs and "white noise" generators can help to make the bedroom more relaxing.

snow globe

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THE COMPLETE COLUMBIA MOUNTAINS TRAVERSE ATTEMPT

in this **section**

// CRAIG ELLIS

Walking Away

An attempt at the full Columbia Mountain traverse leads the participants to ask: **What does success mean?**

Lynnea Baker and Alex Heathcott, with contributions from Eliot Brooks

THIS PAGE: THE COMPLEX TERRAIN OF THE CARIBOOK MOUNTAINS. OPPOSITE: ENJOYING LUNCH IN THE CARIBOOKS. // NIKOS SCHWELM

BETWEEN MARCH 11 AND MAY 2, 2019, *Alex Heathcott and Lynnea Baker spent 44 days traversing the Columbia Mountain Range. The trip followed Dan Clark and Chris Gooliaff's 1998 traverse and was the second attempt at linking the grand traverses of the Columbia Mountains.*

OUR ROUTE BEGAN at the southern tip of the Purcells in St. Mary's Alpine Provincial Park and ended at the North Thompson River in the central Cariboos. The trip had four distinct sections split up by roads, where new partners joined us to make parties of three or four.

Each segment posed different challenges that required careful judgment and a variety of management tools. In the Purcells, we were caught in the first spring warm-up. Hazard rose to extreme across southern B.C., causing us to bail out of the backcountry until the snowpack stabilized and we could resume. In the Selkirks, we were plagued with unstable weather, constant snowfall, and deep trail breaking. Fortunately, a widespread avalanche cycle had cleared out much of the hazard in the Monashees, allowing us to pass smoothly.

The fourth and final segment of the traverse was the Cariboos, where we were joined by Eliot Brooks and Nikos Schwelm. After 35 days of skiing, we were mentally and physically exhausted, but with only two weeks left, the end felt in sight.

On our second day in the Cariboos, travelling across the first alpine feature of the day, we remote triggered a size 1.5 avalanche—the first and only skier accidental of the trip. A huge cornice overhung the second slope, which had looked relatively benign on the map. The terrain felt much less straightforward than expected. We anticipated spring conditions, yet the alpine seemed to have many mid-winter hazards. The realization sunk in that some seemingly minor slopes would pose serious risks in the current conditions. For the rest of the day, we played the angles, sought out old avalanche debris, and carefully assessed the consequences of each slope. It was mentally exhausting.

On day three, we received word we were about to catch the edge of a storm, with forecasted alpine winds of up to 100 km/hr. After coming this far we were unwilling to bail based on a forecast. We chose to race the storm to the safety of treeline on the north side of Manteau Peak.

As we crossed the glacier towards Manteau Peak, the storm was visible at the edge of the valley to the east. We briefly debated our options and hurriedly bootpacked up the col, punching through wind slab and isothermal snow onto the wet rock slab below. The neighbouring slope had released in the last 24 hours.

We skied down the far side of Manteau to the safety of a clump of trees below. As we set our backpacks down, the wind escalated to full force.

When we woke the next morning, the landscape had transformed. Everywhere we looked there were scoured ridgelines, cross-loaded slopes, and reverse cornices. A large avalanche cycle had released overnight. Feeling too apprehensive about the wind slab and consequence in terrain so big and remote, we decided our planned route above treeline was no longer safe. We skied down to the safety of the North Thompson FSR.

Over the next few days we slowly moved forward and deliberated whether we could continue and make it safely over Mt. Sir Wilfred Laurier before the arrival of another forecasted wind event. Our state of mind, exhaustion, the terrain, and the snowpack all weighed heavily on us. We discussed our options: ski out the road to the highway, or up to our food cache at McAndrew Lake and onto the Raush Glacier.

There was an obvious divide in the group's motivation to continue, but our emotional commitment to the trip won out and we decided to push on to the food cache and re-evaluate there.

Two days after the wind event, we discussed our options from our camp on the Raush Glacier. For each of us, red flags came from different places.

Alex Heathcott

The Cariboo segment of our traverse was a problem before the trip began. When mapping the traverse, I originally only envisioned us skiing to Mica Dam. As the planning progressed, I shifted my focus to the entire Columbia Mountain range and tacked on the Cariboos. It was a range I had never explored and I researched the route significantly less. I was convinced we would experience late-spring conditions and focused on staying as high as possible, often mapping routes through improbable terrain. After staring at the map for months, this high line, off the traditional Northern Cariboos route, became imprinted in my mind as the only way through.

When we arrived in late April, mid-winter conditions persisted, and it was immediately obvious we were going to have problems. Staying true to the planned route, we continuously put ourselves into committing positions, unsure of alternates. As new challenges presented themselves, our confidence in ourselves, the route, and our future began to wane. For the first 35 days of the traverse, I was up front most of the way, leading all of the technical cruxes. Now, my energy deficient body was barely capable of carrying my load, and for the first time on the trip, one of our new partners was leading the way.

On top of the physical challenges, there was also a divide between Lynnea and I. By the time we reached the Cariboos, we were operating as two individuals rather than partners. A series of close calls and bad decisions led to a growing distrust in each other, compromising our ability to rely on each other's decision making.

Lynnea Baker

Collecting beta before the trip, everything I had heard about the Caribou's was that it was fairly straightforward, and I went into our final segment with that attitude. As we got into the alpine, I was alarmed to find that what looked like benign terrain on the map was consistently more challenging than expected. Additionally, the mid-winter conditions in the alpine forced me to adjust my spring travel mindset into reading every slope. Spooked, I started to doubt my understanding of the complex terrain we were moving toward and became less confident we had the conditions for safe travel.

Mental fatigue was setting in for me. I wondered if our group was suffering from non-event feedback. Although we had faced numerous situations and conditional challenges, we had managed to persist. I had started to wonder if we were getting away with a lot rather than making good, sound decisions. How close we came to the line during the wind event reaffirmed that for me. Had we been delayed in the alpine or stuck at the col before the wind hit, the consequences would have been severe. I knew that I had pushed us into that position.

Eliot Brooks

As an outside observer attending the trip with a fresh set of eyes and legs, decision making was obviously emotionally affected. How could it not be? Years of preparation and weeks

FROM LEFT: ELIOT BROOKS, LYNNEA BAKER, AND ALEX HEATHCOTT ON A COLD MORNING NEAR PAPINEAU PEAK. // NIKOS SCHWELM

ELIOT BROOKS AND LYNNEA BAKER DIG OUT THEIR TENT FOLLOWING THE WIND EVENT NEAR MANTEAU PEAK. // NIKOS SCHWELM

of skiing toward a common goal are not easily forgotten. Even if the conditions were closer to ideal, I would have been uncomfortable with the emotional investment in this segment of traverse. That's not to say they were making objectively bad decisions, it was more that their interest in completion heightened their risk tolerance.

I think it startled Alex and Lynnea to find our tolerance and perceptions of risk to be so far out of alignment. That alone was the first red flag.

The second was the snowpack. Due to the variability of the snowpack before the storm, predicting what we would find on any given slope was extremely difficult and unreliable. Would it be scoured to basal facets? Or loaded multiple wind slabs on an isothermal mid-pack?

The third red flag was the complex terrain ahead of us. Large, rocky start zones perched on top of huge glaciated, planar slopes did not inspire confidence in our planned route. Normally, I would be comfortable stepping out into extreme terrain like this with good to moderate avalanche conditions. Here, we would be relearning the snowpack as we travelled through this terrain, which made me uncomfortable.

That thought process, combined with how my partners were already assessing risk and making decisions on how to move through terrain, was enough for me to want to pull the pin.

I think Lynnea and Alex had started to shift into a fatalistic mindset, which I felt obliged to break down, resulting in us walking away.

Alex

Standing on the Raush Glacier, I realized we had neither the right conditions nor the right team to continue on my dream route, which crossed over Mt. Sir Wilfred Laurier and Mt. Sir John Abott and involved technical climbs and descents. With our confidence shaken, the group was not moving fast enough to do the technical climbs, especially not while racing an incoming storm.

We had two alternate options to continue: descend to the Raush River or backtrack to the standard Northern Cariboos route. The former would have involved days of heinous mud and isothermal snow, while the latter would have put us at risk of running out of food, and offered even fewer options for egress. With neither option sounding good, we chose to call it and walk back out the North Thompson FSR.

Lynnea

We were having trouble reaching consensus as a group on whether we should bail out now or keep going. For my part, I certainly kept trying to push the group forward to gather more information about the wind slab. On a trip this size, it is important to vocalize and realize the roles we each play in a group. Alex and I always had our end goal in mind, whereas section partners who had less invested found it easier to fit into the contrarian leadership role. A successful trip of this magnitude has both roles filled and a lot of luck from the rest of the world.

The final straw for me came when Eliot said, "If you guys weren't on a huge expedition, we would have bailed out three days ago." He was absolutely right and I knew it. That closed the decision to leave for me. His comment snapped me back to reality and made me realize that normally, without the external pressures, I would have easily turned around and not cared.

I was disconnected from the decision-making process. Conditions were challenging at best and the terrain ahead was complex. Days on end of being together was making Alex and I bitter and estranged. I was burnt out and had stopped enjoying the things I love about being in the mountains. Just like that, the end goal lost its value.

It is not surprising to me I was stuck in an objective-driven mindset. How could I not be when we were on an objective-based trip? I had taken months off work, Alex had flat out quit his job. We spent half a year organizing the trip and even received financial backing. I felt a lot of pressure and was highly committed to our goal.

Eliot

As we slogged out of the valley, I wondered if my thoughts and resulting pressures on the group were just borne of discomfort with the depth of the trip, or had I made the right decision? I still wonder if I was just being overly cautious and paranoid. For now, I am forced to stand by my decision and catalogue it into my bank of experience. Hopefully one day I will be able to say whether or not it was the right thing to do, but I doubt it. In this industry of uncertainty, one rarely gets direct feedback on one's decisions, and I will just have to live and learn from that.

Lynnea

In the aftermath of the trip I had a hard time reconciling why we bailed. I felt I wasn't being honest about why it ended, but I didn't want to unpackage those emotions because I knew it would bring up a lot of negative feelings about the trip. I wasn't proud of our accomplishment and I was carrying a lot of shame about the role I played in putting us at risk. When people asked me how I thought it went, I replied that I had mixed feelings. The more I was unwilling to think about it the more it became a lingering failure in my mind.

Before the trip, mentors, parents, and friends cautioned me not to let the pressure of the objective drive the trip. Even though I was aware of the trap, I skied right into it. I realize now success does not come from reaching the finish line. The failure I feel in the trip has caused me to rethink what success is to me in the mountains. I think for me it comes from learning from mistakes, sound decision-making, maintaining open communication within my team, and, most importantly, returning home safely.

All I can do now is learn from my errors to avoid making them on future trips. Creating an environment where all partners are contributing, listening with an open mind, and respecting everyone's role in the decision-making process are my current focuses.

Alex

The final day of the traverse I walked 30 kilometres to the highway alone, wondering whether we made the right decision, or whether we crossed the line earlier and got lucky.

Searching through my memories, I can see when my mental state started to deteriorate, where I shifted from rational to emotional decision-making.

For the first 30 days of the trip, I can picture every campsite, each slope we skied, the food we ate for dinner, and the way we moved with confidence. As the trip goes on, my memory fades, mountains blend together, and entire days are missing. What kinds of decisions did we make those days? What risks did I expose my partners to?

Before the trip, I remember thinking about what a successful trip would look like for me. Completing the entire traverse? Staying safe? Not regretting any of the decisions we made? In many ways, reflecting afterwards has been more rewarding than the trip itself.

When asked, I always tell people about the positive moments: watching the first light come into the sky from high up on a glacier, the towering peaks with endless ski lines, the jokes we shared, and the bathroom emergencies.

People often congratulate me for our decision to walk away so close to the end. I smile and say thanks, but a sinking feeling always creeps into my mind. My head fills with the darker moments: the helpless feeling I had when I nearly drowned in a creek, the urgency we felt as we climbed under a cornice dripping in the afternoon sun, and the fear I had as I watched my ski crampon tumble off my foot to the valley bottom hundreds of meters below.

I'm still not sure whether we were successful or not.

Our trip was only possible with support from the Royal Canadian Geographic Society (RCGS) and MEC, who provided funding for the trip, and a strong group of friends who joined us along the way.

ELIOT BROOKS SKIES AWAY FROM A REMOTE AVALANCHE ON THE SECOND DAY IN THE CARIBOOS. // NIKOS SCHWELM

20 years of Avalanche Québec
Breaking trail in the Chic-Chocs and beyond

Dominic Boucher and Julie LeBlanc

IN THE EARLY MORNING HOURS on Jan. 1, 1999, an avalanche struck a New Year's celebration at a school in the village of Kangiqsualujjuak in far northern Quebec. Nine people were killed and 25 were injured; it is the deadliest avalanche to hit a residential area in Canadian history.

This tragedy was a defining moment for avalanche safety in Quebec. One of the recommendations of the coroner's inquest into the tragedy was to establish a centre for avalanche expertise in the province; Avalanche Québec was born.

According to a historical survey by Professor Bernard Hétu from the Université du Québec à Rimouski, snow avalanches are the second-deadliest natural hazard in Quebec, affecting residences, roads, powerlines, powerplants, mines, forestry operations, and, of course, winter backcountry recreation such as skiing, snowboarding, snowmobiling, ice climbing, snowshoeing, and even tobogganing. Since 1825, about 80 people have died in avalanches in Quebec.

The project to develop the only avalanche centre east of the Canadian Rockies started during winter of 2000 in Sainte-Anne-des-Monts, located at the foothills of the Chic-Chocs mountains. First known as the Centre d'avalanche de la Haute-Gaspésie, the centre became an independent non-profit organization in 2006 and changed its name to Avalanche Québec in 2014.

AFTERMATH OF THE KANGIQSUALUJJUAK AVALANCHE ON JAN 1, 1999. // RADIO CANADA

With the help of the Canadian Avalanche Association (CAA) and the Canadian Avalanche Center (now Avalanche Canada), high-level avalanche safety programs were developed over the years. They became the foundation of our mission to protect the public, prevent accidents, and improve avalanche safety by providing awareness, information, and educational and outreach activities to the people of Quebec.

The education and outreach program includes the management, supervision, and promotion of Avalanche

SINCE 2000, FOUR RECREATIONAL AVALANCHE FATALITIES INVOLVING SKIERS HAVE OCCURRED IN THE CHIC-CHOCS, INCLUDING ONE THIS WINTER. THERE HAS BEEN MANY MORE INCIDENTS IN THE CHIC-CHOCS THAT RESULTED IN SEVERE TRAUMA AND PARTIAL BURIALS. THERE HAS BEEN THREE AVALANCHE FATALITIES ELSEWHERE IN QUEBEC IN THIS PERIOD, INCLUDING A TEENAGER TOBOGGANING (2008), AN ICE-CLIMBER (2015) AND A SNOWMOBILER (2018). // JUSTE.ETRE.DEHORS

Canada Training program courses in La Belle Province. Avalanche Skills Training 1 and 2, Managing Avalanche Terrain, and Companion Rescue Skills courses are offered in French and English by providers all around the province, reaching about 800 participants in 2019.

Avalanche Awareness Days is also a major event and has been organized for the last 15 years in the Chic-Chocs, reaching up to 200 backcountry enthusiasts over one weekend. Other public activities include school presentations, public workshops, and ice climbing and backcountry skiing festivals around the Gaspé Peninsula, and cities such as Montréal and Québec.

The professional training program aims to develop and maintain avalanche safety expertise in Quebec. As part of a long-time partnership with the CAA, the *Avalanche Operations Level 1* course is offered every winter in the Chic-Chocs, with students coming from Quebec, New-Brunswick, Nova Scotia, Newfoundland, Ontario, Alberta, and even from the United States and France. The course is particularly in high demand, with 15 delivered since 2003, including full courses for the last eight years.

For their part, *Intro to Weather* has taken place six times since 2009, *AvSAR* has been run twice since 2014, and a *Level 2 Module 1* course was taught in October 2014 by Marc Deschenes and James Blench. In total, 342 students have taken CAA Industry Training Program courses in Quebec since 2003.

The forecasting program in the Chic-Chocs is by far the most demanding service provided by Avalanche Quebéc. It now involves four forecasters and three technicians who gather data from the field and then prepare the forecast (InfoEx is still very embryonic in the region). Since 2002, the avalanche bulletin has been produced in both French and English to accommodate visitors from Quebec, the Maritimes, Ontario, and the eastern United States. First published once a week and posted at trailheads, the forecast is now published every day from December 1 to April 30 on our website. It includes the danger rating, avalanche problems, avalanche observations, snowpack summary, and weather forecast.

To provide real-time data, remote weather stations were installed in the valley, at mid-elevation, and on the mountain tops in 2003. The forecasting team, local backcountry ski operations, and the public can access essential wind, precipitation, and temperature from the Avalanche Quebec web site.

Average snowfall over the last 10 winters at our valley weather station (230 metres above sea level) is 364 centimetres, with a high of 507 centimetres recorded in

AVALANCHE QUEBEC HAS PUT A LOT OF EFFORT TOWARD AVALANCHE EDUCATION SINCE ITS BEGINNING. RECREATION COURSES WERE OFFERED AS EARLY AS 2002. PARTICIPATION IS INCREASING EVERY YEAR, WITH 800 PEOPLE TAKING COURSES IN 2019 // JUSTE.ETRE.DEHORS

THE FIRST AVALANCHE ADVISORY WAS PRODUCED FOR THE FORECASTING AREA OF PARC NATIONAL DE LA GASPÉSIE AND RÉSERVE FAUNIQUE DES CHIC-CHOCS IN 2002. IT WAS PUBLISHED ONCE A WEEK AND POSTED AT TRAILHEADS. THIS WINTER, A COMPLETE AVALANCHE FORECAST IS AVAILABLE DAILY FROM DECEMBER 1 TO APRIL 30. // JUSTE.ETRE.DEHORS

2010-11. Recorded winds at our mountain top weather station (1,150m asl) regularly exceed 150 kilometres per hour. This contributes to our main wind slab avalanche problem omnipresent throughout the season. The forecasting program in the Chic-Chocs also includes alpine weather forecasts provided since 2010 by our partner Alpine Weather Consultants in Vancouver.

Special projects aim to improve avalanche safety in Quebec and support the sustainable development of winter tourism in the Chic-Chocs. The Chic-Chocs guidebook was published in 2010 and has sold more than 6,000 copies. Available in French and English, this book includes maps, terrain ratings using the Avalanche Terrain Exposure Scale, and photos to help backcountry users plan and carry out safe trips. Since 2019, a mobile version of the guidebook has been available, allowing real-time localization on downloadable maps. Weather forecasts and avalanche bulletins are also integrated into the app.

Another special project is supporting the development of the Quebec Ministry of Transportation's avalanche safety program on a 70-kilometre stretch of road, including Highways 132 and 198 in the Haute-Gaspésie. These roads are sandwiched between the shore of the Gulf of St. Lawrence (Hwy. 132) and L'Anse-Pleureuse Lake (Hwy. 198) on one side and cliffs and steep slopes on the other. They are threatened by over 100 avalanche paths that produce several dozen slides up to size three that block traffic either partially or completely every winter

Since the beginning, funding has always been an issue. Over the last few years, Avalanche Québec has worked closely with Avalanche Canada on the national strategy proposed to the federal government in order to secure public funding for avalanche safety in Canada. A one-time endowment of $25 million was announced in November 2018 and signed in July 2019. The federal contribution is aimed to first stabilize existing programs and then allow for expansion of activities and services.

At Avalanche Québec, this money made daily forecasts a reality this winter for the first time. New projects will emerge from this strategy: improving public education throughout the province, mainly with youth; expanding the forecasting area in the Chic-Chocs, developing a forecasting program in Charlevoix, Bas-Saguenay, and Côte-Nord regions; and participate in special avalanche warnings and advisories for Newfoundland.

AVALANCHE QUEBEC'S FOUNDER AND LONG-STANDING EXECUTIVE DIRCETOR, DOMINIC BOUCHER // JUSTE.ETRE.DEHORS

Wanted:
ISSW Presentation Abstracts

Mary Clayton

DO YOU HEAR THAT NOISE? That's the sound of a window of opportunity slowly closing. The deadline for submitting an abstract for consideration to present at ISSW 2020 is April 27. There's still time if you're stuck in the "should I or shouldn't I?" phase, but you need to get off the fence and get in front of a computer. And the answer that question is a definite, "Yes, you should."

The International Snow Science Workshop is a unique opportunity to share your ideas with hundreds of your peers, many of them from other countries. This takes networking to a whole new level. Indeed, there are several examples of successful research projects borne from a thought-provoking ISSW presentation.

So, how do you get a spot to present at ISSW? The first step is to write an abstract: a 250-word summary of your presentation concept. Think of this as the what, why, and how. What is the question you are addressing in your presentation? Why is it important? How did you explore the topic? What did your exploration reveal? And what are the main take-away messages for the audience?

An abstract is your chance to whet the readers' appetite to know more. Think about your audience, who are researchers and practitioners. You want to make your topic relevant to as many ISSW participants as possible. Check out issw2020.com/call-for-abstracts for more details on the conference themes and the process of submitting an abstract.

It's always a good idea to reach out to someone with presentation experience. Bounce your ideas off them before you start typing, and get them to read your abstract before you submit. Once your abstract is in, it goes before a committee headed by Dr. James Floyer, one of the supervisors of Avalanche Canada's warning service. The committee comprises researchers and practitioners. They review all the abstracts and decide where the topic fits within the general themes of the conference, and whether it will be an oral or poster presentation.

If you are assigned an oral presentation, you'll have 15 minutes, with another five for questions from the audience. Visuals are optional but strongly recommended—you want to keep your audience engaged. A poster presentation means you communicate your ideas visually on a poster board measuring approximately 1.2m x 2.3m. During the poster session, you have the opportunity for more direct, one-on-one engagement with delegates.

ISSW 2020 will have a strong focus on practitioners, with a 90-minute panel discussion running every afternoon (except Wednesday, the field day). These discussions will centre on topics relevant to front-line workers and promise to yield a stimulating and thought-provoking exchange of ideas.

ISSW is for you. Don't miss this opportunity to further your knowledge and deepen your engagement with the wider community of avalanche professionals. Even if you're not quite ready to present, being a delegate brings many rewards. Registration will go live on April 14 and the ISSW committee has organized a discounted rate for accommodations.

ISSW sponsors play an important role in the success of the conference and this year's Presenting Sponsor is CIL Explosives. The National Supporting Sponsor is Teck, and TAS is the Supporting Sponsor. In addition, the following companies have already signed on with greatly appreciated support:

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