the avalanche journal

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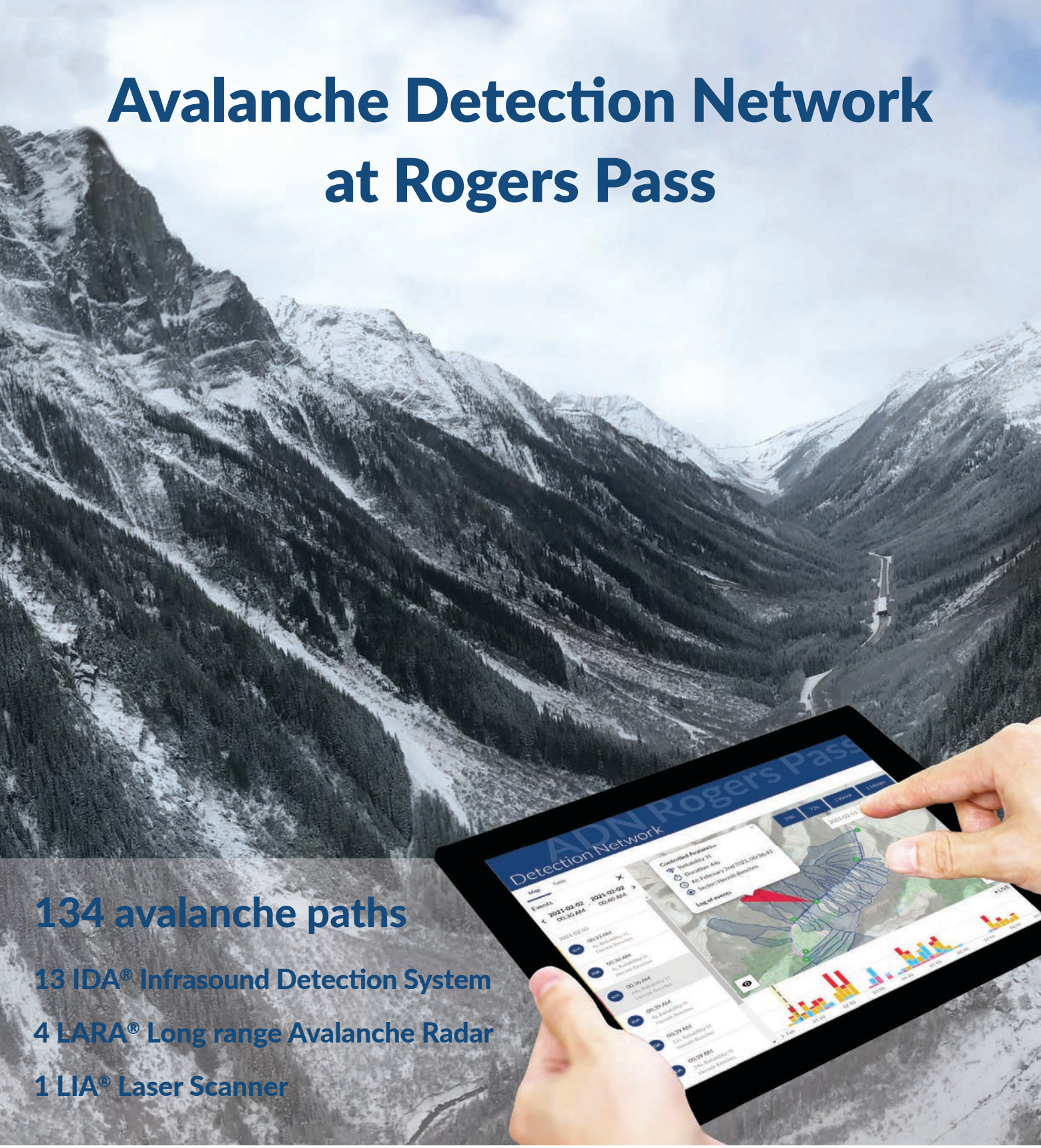
THE VOICE OF **CANADA'S** PROFESSIONAL AVALANCHE COMMUNITY

$10

Avalanche Detection Network at Rogers Pass



134 avalanche paths

13 IDA® Infrasound Detection System

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North Shore Rescue, in Vancouver, were the first in Canada to adopt the system and have added it to their rescue plan. North Shore Rescue covers the mountain playground of Vancouver and each year responds to multiple missing and injured person calls. The second Canadian RECCO SAR detector is in Canmore, Alberta, and operated by Alpine Helicopters serving Parks Canada and Kananaskis Parks. The key to success of this system is for you to become searchable with a RECCO Reflector and indicating that on your trip plan.

You can make yourself searchable with RECCO technology by choosing outdoor gear with integrated RECCO reflectors or through attachable RECCO rescue reflectors that can be fixed to a backpack or helmet. In Canada attachable RECCO reflectors are available through BCSARA's website.

Canada is one of seven countries worldwide that have the RECCO SAR system in place and ready to use for rescue. Four units are in use in the USA, located in Washington, Montana, Utah, and Wyoming. In Europe helicopter rescue organizations in Sweden, Norway, Austria, Switzerland, and Italy are equipped. Austria was the first country of all, providing full coverage of the complete federal Austrian area.

RECCO is continuing its quest together with its rescue partners to add more locations to the list in existing countries to reach full coverage where it is needed, and to add new countries.

the avalanche journal

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SUMMER 2021

in this **issue**

Walter Bruns
CAA President

CAA President's Message

RETURN TO NORMALCY

AFTER SOME FITS and false starts, summer finally arrived in the Bow Valley just as some COVID restrictions were being lifted. It's like coming out from an unscheduled and unwelcome 16-month hibernation! What a pleasure it is to reconnect in person with family, friends and colleagues.

The CAA is returning to normal interaction among staff and with members. There are more people in the Revelstoke office again—stay tuned for updates on dropping in to access services.

Thank you to all the members who participated in our second virtual AGM and who voted to return all incumbent directors. Steve Conger joins the board, bringing with him extensive experience as past chairs of the Education Committee and the Ethics and Standards Committee.

With recommendation from the Governance Committee, the board elected Eirik Sharp as Vice-President, Jesse Percival as Secretary-Treasurer, and myself as President for a final year. Kerry MacDonald was confirmed as chair of the Membership Committee.

Steve will get right at it by spearheading the completion of the Guidelines for Instruction in Avalanche Terrain. Eirik and Kerry will rekindle the effort to determine names for the Active and Professional membership classes. The board will meet (mostly) in person in late September to review and renew the Strategic Plan.

As Joe mentions in his piece, the board has authorized an inclusivity statement for the CAA. This is a natural step for an organization like ours and sets out commitments that we value. A significant component of our strategic planning will be to insert inclusivity goals to inform our actions.

There has been extensive consultation on these various initiatives in the past, and there will be more to come. Staff will update you via the membership newsletter and solicit your comments and suggestions.

As our world returns to some semblance of normalcy, I hope that your world does so as well. Whether it is public recreation, tourism in the commercial sector, travel through mountain corridors, or remote industrial activity, a resurgence in all aspects of avalanche work can be anticipated. ITP courses are open for registration, with strong demand expected.

But for now, it is summer! Enjoy the break.

Walter Bruns, CAA President

Executive Director's Report

Joe Obad
CAA Executive Director

OPENING UP

I THINK WE ALL LOOK FORWARD to a time when regular communications no longer include references to the pandemic. Like an unwanted stitch, it seems sewn into all our interactions. Having said that, signs that vaccines have COVID-19 on the run are encouraging. The provinces are mostly entering new stages for openness. Perhaps soon we'll take lessons from the pandemic to improve our operations and interactions. Openness on several fronts is needed.

At the CAA we have run two virtual conferences now. These have compelled use of new tools for online voting, annual reporting, and participation for members unable to join an in-person meeting. As much as the pandemic closed many activities, these steps opened new opportunities for engagement and new obligations. In 2022, if circumstances allow, we will most likely run a blended conference that uses the strength of in-person meetings while allowing members to join via remote connections.

Opening up through technology is relatively simple compared to some other challenges we are taking on. In this issue, you will find the CAA's Inclusivity Statement on page 12. Many organizations are issuing similar statements; the test is how organizations live up to these commitments to respond inclusively to Canada's diversity. We have begun some basic steps at the CAA by providing training to staff, board members, and ITP instructors. Recent examples include legal training on our positive obligations relative to ensuring we address the human rights as defined in the Charter for those with whom we engage. We have also undertaken training from the Calgary Centre for Sexuality. Over time, we seek to ensure these lessons are incorporated into how we engage students, members, and other stakeholders. Walking the walk on this journey is not simple so we welcome your feedback as we proceed.

We are also taking additional steps to recognize our obligations as a national organization. Some days, with our heads in the weeds of supporting members where demand is greatest, we can default to being the CAA of western Canada, or the CAA of BC, or even the CAA of Revelstoke. But our mandate demands we look further and more openly. This is especially true for our members in Quebec.

Nos membres au Québec font face à plusieurs défis. Notre site Web, nos articles techniques et nos normes sont pour la plupart en anglais. De plus, le processus d'adhésion révisé introduit en 2021 présente des défis à relever au Québec où il y a moins d'opérations et moins d'opportunités d'apprendre et de développer des compétences dans des environnements structurés.

Nous ne pourrons pas relever tous ces défis dans l'immédiat, mais nous pouvons commencer à prendre des mesures dans la bonne direction. Nous avons conclu une entente avec Avalanche Québec pour nous assurer que les communications clés sont traduites en français. De même, un dialogue s'est amorcé autour des enjeux de l'adhésion à la CAA pour les Québécois éloignés des montagnes de l'Ouest. Ce sont des débuts mais des conversations importantes pour être ouverts et à l'écoute des besoins des membres du Québec.

Openness also means recognizing the work of our partner organizations. We have worked with the ACMG to recognize some of the equivalencies their training provides relative to the competencies that need to be proven in our Professional Member application process. We have had some preliminary conversations with the CSGA that may lead to similar recognition. It is important to note that these efforts are not favours. Recognizing how standardized training addresses CAA competencies does benefit the applicant, but it also saves the Membership Committee heaps of work chasing evidence for competencies that have already been assessed. In short, these steps benefit both organizations, applicants, and the committees and staff who support the application process.

I hope these windows into our activities are helpful to members. All of us staff look forward to more open meetings with you in the near future—meetings with fewer screens and more handshakes and hugs—some openness we'd all welcome. Until then, we all hope you enjoy the gifts of summer before the season ahead.

Mike Wiegele (1938–2021)
As we were finalizing this issue we learned of the death of Professional Member Mike Wiegele, a giant in the heliskiing industry and champion of avalanche research. Our thoughts are with his wife Bonnie, daughter Michelle, the Wiegele family, and everyone at Mike Wiegele Helicopter Skiing. We look forward to offering a fuller remembrance of Mike in the next issue of the Journal.

Joe Obad, CAA Executive Director

Alex Cooper
Managing Editor

From the Editor

AS I WAS EDITING this issue of *The Avalanche Journal*, one word kept jumping out at me: "debiasing." It showed up prominently in two articles that looked at persistent slab problems in the southern Coast Mountains, and again in another on the strategic mindset. In the context of the articles, it was about debiasing oneself from perceived conceptions of a coastal snowpack (that they heal quickly) and recognizing that persistent weak layers are a problem there.

Where it also applies in this issue is looking at the CAA Inclusivity Statement on page 12. The first objective states: "All individuals' work or contributions are assessed on their merits without consideration of race, colour, ancestry, place of origin, religion, family status, marital status, physical disability, mental disability, sex, gender, age, sexual orientation, or political belief." Reading this, it occurred to me that debiasing applied here as well.

DEBIASING

When I look at myself, I realize I check most, if not all, of the boxes for privilege in western society. I'm conscious of this, and try my best to ensure my privilege doesn't influence the way I act towards others. But I carry biases that affect my actions and reactions. If someone says, "This makes me uncomfortable," or "Don't say that," it's my job to listen, not to project my privilege onto them. The website Effectivology provides a good basis for ridding ourselves of our cognitive biases: "When it comes to reducing cognitive biases that revolve our tendency to underestimate how different other people's views are from our own, one useful debiasing technique is to visualize how a certain situation looks from someone else's perspective." [1]

In the context of the articles in this issue of the *Journal*, debiasing is about ensuring one's preconceived notions of a coastal snowpack doesn't affect one's forecasting. But it also applies to being a more diverse and inclusive industry.

***

I've got some exciting news to announce for this issue of *The Avalanche Journal*, which you may have noticed already—it's in full colour! It's been a long-time coming, but we're happy to provide this publication to you like this. No more converting coloured charts and graphs to grayscale, and no more difficult editorial decisions deciding which articles receive the colour treatment and which are relegated to black-and-white.

Many thanks to Brent Strand for reaching out to the printers to make this happen, and Kristin Anthony-Malone for approving the move. The first volume of *The Journal* was printed over 40 years ago on eight 8.5x11 sheets of paper by the Ministry of Transportation. It has come a long way since then, slowly developing through several iterations into the magazine it is now. We hope it has achieved its final form in full colour and that it makes your reading experience more enjoyable.

As mentioned above, this issue has two articles looking at recent persistent slab problems in the southern Coast Mountains. Tim Haggerty wrote about the persistent weak layer that plagued Whistler Mountain at the start of the 2019-20 season and presented challenges both in terms of managing the layer and communicating terrain closures to the public. Simon Horton provides an overview of fatal avalanche incidents in the southern Coast Mountains, showing that most are the result of persistent slab problems, and looks at new ways to use snowpack models to forecast them.

Colin Zacharias wrote about his strategic mindset for recreationists. While this is not part of Avalanche Canada Training curriculum yet, I know it is being thought about. Elsewhere, the patrol team from Castle Mountain looks at a tricky avalanche problem and unconventional rescue at their resort. Pascal Haegeli provides some more insight from the comprehensive avalanche forecast surveys conducted by his team at Simon Fraser University, and Mark Sedon from New Zealand provides some research into tap test forces. Finally, Greg Hill wraps things up with insight into mitigating avalanche hazard on his recent 53-hour traverse from Rogers Pass to the Bugaboos.

I hope this summer treats you well, wherever you are. It is off to a foreboding start out west, with record shattering temperatures and numerous wildfires sparking in the wake of the late-June heat dome. I can only hope summer is not smothered in smoke.

Alex Cooper

[1] https://effectiviology.com/cognitive-debiasing-how-to-debias/

A Challenging and Memorable Year for ITP

Andrea Lustenberger, ITP Manager

THE 2020-21 WINTER SEASON will be a year to remember for the Industry Training Program. Because of public health orders brought about by the pandemic, we had to be dynamic, and lots of planning and adapting was involved. Thankfully, our courses were deemed essential by public health officials and were able to proceed, with many precautions put in place. It wasn't easy, but at the end of the year we were able to host 723 students in 38 in-person courses. Unfortunately, we did have to cancel two Intro to Weather courses scheduled at the beginning of May in Penticton, but given all the challenges we faced, we consider the season a success.

2020-21 INDUSTRY TRAINING PROGRAM COURSES	
AVALANCHE OPERATIONS LEVEL 1	13
AVALANCHE OPERATIONS LEVEL 2	11
AVALANCHE SEARCH AND RESCUE ADVANCED SKILLS	7
INTRODUCTION TO WEATHER	4
ADVANCED WEATHER	1
AVALANCHE CONTROL BLASTING	1
RESOURCE AND TRANSPORTATION AVALANCHE MANAGEMENT	1
TOTAL COURSES	**38**
TOTAL STUDENTS	**723**
INTRODUCTION TO AVALANCHE OPERATIONS – ONLINE COURSE(ONLINE)	
TOTAL STUDENTS	**402**

The updated Level 2 program was particularly succesful. The program now has two parts instead of three—an eight-day course followed by a six-day assessment—and both instructors and students had positive comments.

The year would not have gone so smoothly without the hard work of so many people. Thank you to our partners and venues who continued to support us and helped implement health measures. Thank you to my co-workers at the CAA who adapted throughout the year as we changed venues, increased COVID-19 supplies, adjusted the schedule and registration timelines, and much, much, more. Most importantly, thank you to all of the students and instructors who diligently managed COVID mitigation to keep others safe and healthy.

LOOKING FORWARD

We are spending the spring and summer preparing for the 2021-22 ITP season and are increasing the number of courses being offered. We are monitoring the provincial COVID restart plans and will be continuously updating the ITP COVID safety plan to align with provincial regulations. Registration for the Level 2 program and most fall courses will have already occurred by the time you read this, while registration for Level 1 takes place in September. Curriculum work is underway to update several courses throughout the summer and fall.

We look forward to seeing everyone again in the fall, hopefully under less strenuous circumstances.

Welcome **Maris Fraser, ITP Coordinator**

Maris Fraser is joining the CAA team as the new Industry Training Program Coordinator. She is eager to learn from and work with the best at the Canadian Avalanche Association. She brings eight years of experience raft guiding, ski instructing, and working as an outdoor educator. Maris loves all things rivers and mountains and is excited to start her journey in the avalanche industry with this incredible organization.

ON JUNE 16, 2021, THE BOARD OF DIRECTORS APPROVED AN INCLUSIVITY STATEMENT FOR THE CANADIAN AVALANCHE ASSOCIATION. THIS IS A NATURAL STEP FOR OUR ASSOCIATION. CANADIAN SOCIETY HAS CALLED FOR ITS INSTITUTIONS TO BE MORE DIVERSE AND INCLUSIVE. THE CAA ACCEPTS ITS OBLIGATION TO RECOGNIZE CANADA'S DIVERSITY AND TO ACT IN AN INCLUSIVE MANNER AS IT ENGAGES WITH MEMBERS, STUDENTS, EMPLOYEES, THE GENERAL PUBLIC, AND OTHERS. THE INCLUSIVITY STATEMENT BELOW DESCRIBES GENERAL PRINCIPLES THE CAA ASPIRES TO AS WE EMBARK ON THIS JOURNEY. WE RECOGNIZE THAT WE DO NOT MEET ALL THESE OBJECTIVES AT THE CURRENT TIME, BUT ARE WORKING TO REVISE OUR PROGRAMS TO GET CLOSER TO THESE IDEALS. THE STATEMENT ITSELF IS SUBJECT TO CHANGE OVERTIME AS REQUIRED.

WE WELCOME YOUR FEEDBACK. IF YOU HAVE ANY COMMENTS, PLEASE LET US KNOW VIA INFO@AVALANCHEASSOCIATION.CA

CAA **Inclusivity Statement**

Approved by the Board of Directors June 16, 2021

STATEMENT:

The Canadian Avalanche Association actively works to foster a diverse and inclusive professional culture, where an individual's work, contributions, and access to opportunity are assessed on merit, without discrimination.

OBJECTIVES:

The Canadian Avalanche Association strives to offer services to our membership, students, and other stakeholders in a manner that supports the following objectives:

- All individuals' work or contributions are assessed on their merits without consideration of race, colour, ancestry, place of origin, religion, family status, marital status, physical disability, mental disability, sex, gender, age, sexual orientation, or political belief.
- All individuals feel welcome and safe to participate in CAA Membership, training, and events at whatever capacity and level is appropriate for their abilities, experience, and training.
- All individuals feel welcome to engage in open conversations around inclusivity, without fearing reprisal.
- All individuals accept that mental health and discrimination pose difficult psychological challenges within the profession, and they are empowered to ask for help and share their learnings without fear of judgement.
- All individuals participate actively in examining and overcoming unchecked personal or organizational biases that lead to harmful actions and perceptions.
- All individuals recognize the objectives above require dedication and lifelong learning.

Fuse News

Steve Brushey

"LEARN FROM THE MISTAKES OF OTHERS. YOU CAN'T LIVE LONG ENOUGH TO MAKE THEM ALL YOURSELF."
~ ELEANOR ROOSEVELT

RUPERT WEDGWOOD PROVIDED the Explosives Advisory Committee with this quote during our virtual meeting on May 4. It resonated with me and it's on that premise that I was inspired to provide the membership with a summer Fuse News. It provides a nice segue into the committee's request to ensure all operations that use explosives report blasting incidents via the InfoEx. The EAC's role is well defined in our terms of reference and although we encourage everyone to report their mishaps, we certainly do not police it. (By regulation, operations are required to report all blasting incidents to the appropriate federal and/or provincial regulators.)

The intent of using the InfoEx is simply to learn from one another's incidents so they aren't repeated. The Winter 2021 Fuse News highlighted this by borrowing a quote from James Reason: "Effective risk management depends crucially on establishing a reporting culture."

Although the EAC didn't have the opportunity to present our work at the Spring Conference, I would like to take the opportunity to share the percentage of InfoEx reports by topic from the past winter (Figure 1), which provides some insight into the aspects of explosive use where incidents are occurring.

Regular training is important for all explosives users. For those less experienced, good supervision and mentorship provides a solid foundation for new practitioners. Explosive failures are rare since products have become highly reliable, but when something goes wrong, it is quite likely human error was involved. The intention is not to criticize, but to provide further insight into the high value of regular mentored training. Great strides have been made in safety and quality assurance within many industries that have the willingness and tenacity to investigate the lessons that often exist when we fail. As Matthew Syed put it in his book *Black Box Thinking*: "It is about creating systems and cultures that enable organisations to learn from errors, rather than being threatened by them."

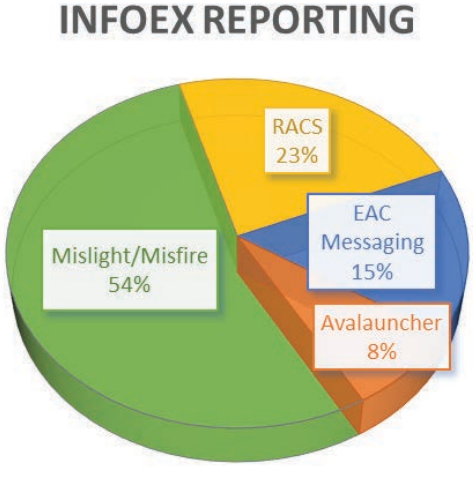


FIG. 1: WINTER 2020-21 INFOEX REPORTS RELATED TO EXPLOSIVES, BY TOPIC.

The EAC always welcomes feedback—good or bad. It is how we evolve so we can continue to represent our membership. Our last Fuse News generated some discussion amongst the membership. As Chair, I acknowledge I was simply too busy to not only write the Fuse News, and did not take the time to provide feedback to either author. Those with a keen eye for detail caught nuances that suggested there were procedural shortcomings with a helicopter control training mission. In fact, the author (a new EAC member), was also very busy, pressed to meet writing deadlines, and simply omitted details of how the mission unfolded in order to stay within the word limit. As Chair, I pretty much sandbagged my two members. Lesson learned!*

Other work on the EAC docket includes:

- Work with WorkSafeBC on the suggested changes to blasting regulations as described by WSBC Officer Chris Elliot during the Spring Conference.
- At the suggestion of RACS users, the EAC will establish an online forum on the CAA members-only site where RAC issues and topics can be discussed. The intention is to provide a transparent platform where a conversation can take place similar to the ACMG's INFORMALEX. We still encourage everyone to use the InfoEx to report all blasting-related incidents.
- It was suggested that one or two EAC members sit in on the CAA Blasting Course as observers to offer feedback. Certainly, for myself, who has not taken that course, I do see a good benefit to this.
- At the suggestion of CIL rep Braden Schmidt, I took the opportunity to join the International Society of Explosive Engineers. Having attended the one webinar this past winter, I saw value in joining. There is certainly room for our industry to grow within this organization and I encourage anyone who meets the ISEE requirements to also join.

Enjoy your summer! Thanks to everyone who contacted us this past year, provided feedback, and offered advice. The EAC is transparent. The EAC strives to be an industry leader and with the effects of the pandemic bringing the world that much closer together, being the best we can be makes sense.

**Editor's note: As the Managing Editor, I'll try to be more flexible on word counts.*

Contributors

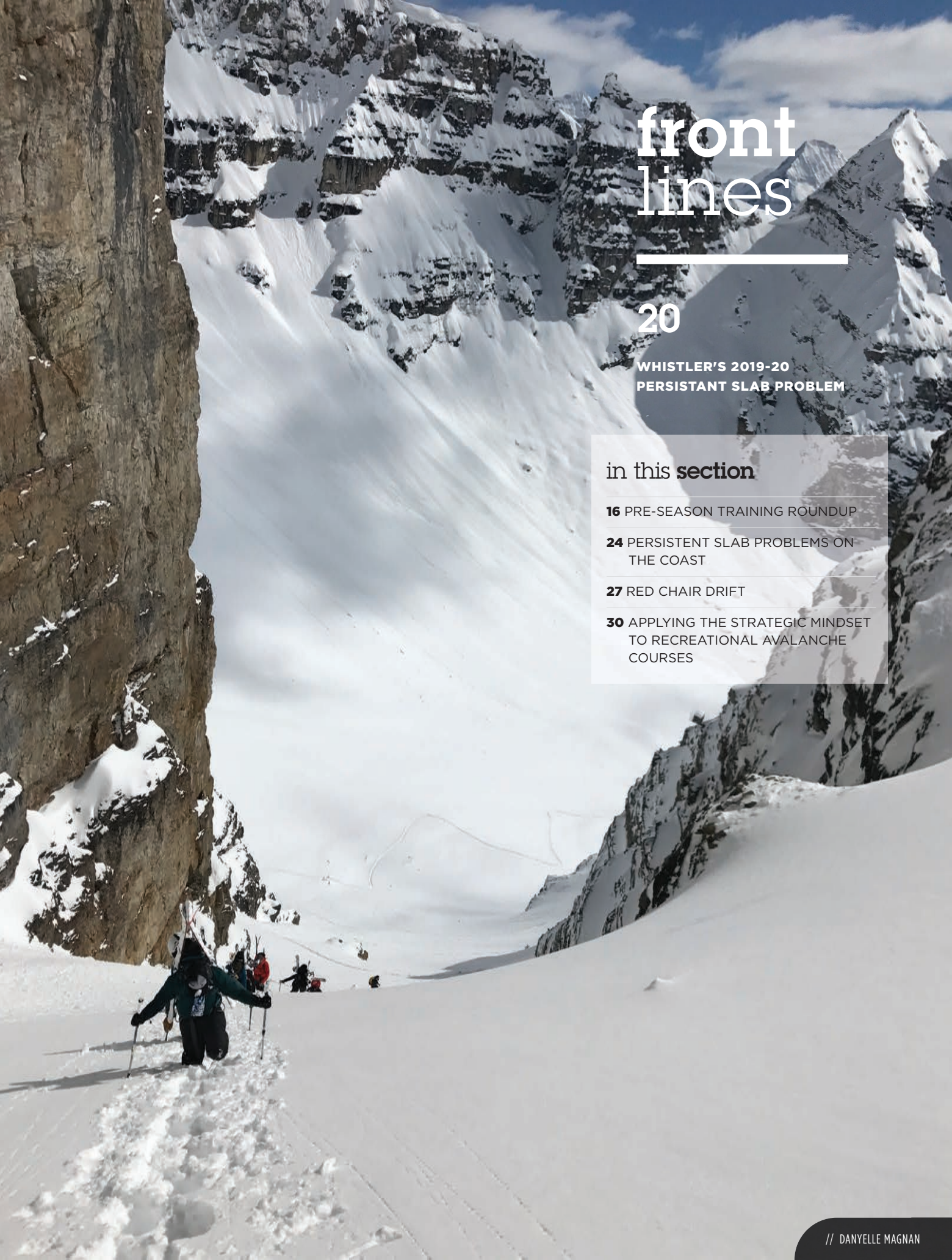



MITCH SULIAK started out in the avalanche industry ski patrolling at Castle Mountain Resort. After five seasons, he headed north where he spends his winters working for MoTI's NW Avalanche Program based out of Terrace, BC. **AMANDA GOODHUE** has worked as a patroller at Castle for 10 years. **GRAHAM CZIBERE** has worked as a ski patroller at Castle for four years. During the summer he is a playground installer throughout western Canada and is presently returning to school to become a teacher. **DAVE STIMSON** has worked at Castle for 13 years and is now one of the Mountain Safety Managers. He recently became an IFMGA guide and spends his summers in California.
27 RED CHAIR DRIFT

COLIN ZACHARIAS is an IFMGA/ACMG Mountain Guide and has completed the CAA Level 3 program. Employed in the industry since 1980, he works as a mountain safety consultant, backcountry ski guide, and avalanche instructor with the CAA. His consulting work has included ski areas, mechanized guiding, transportation and industry, and as a subject matter expert for a Vancouver legal firm. He has helped develop educational curriculum for the CAA, ACMG, and AIARE; and is a former technical director of the ACMG and AIARE. Colin lives with his wife on the west coast of Vancouver Island where he enjoys surfing and hiking.
30 APPLYING THE STRATEGIC MINDSET TO RECREATIONAL AVALANCHE COURSES

MARK SEDON was a ski patroller for 18 winters and has been an IFMGA climbing and ski guide for the past 20 years. Recently, he has specialized in ski guiding in Antarctica, Kashmir, India; Norway, and New Zealand. He started teaching Avalanche Stage 1 and 2 courses in 1996, is an NZMGA ski guide examiner, and the past chief guide for Harris Mountains Heli-ski.
39 EVALUATING FORCES FOR EXTENDED COLUMN AND COMPRESSION TESTS

TIM HAGGERTY has worked for Whistler Blackcomb for the last 10 years as a patroller and currently works beside Anton Horvath as an avalanche forecaster on Whistler Mountain. Previously he has worked at Sunshine Village and Turoa, NZ, as a patroller and avalanche technician. He teaches for the CAA Industry Training Program and sits on the Education Committee. All his spare time is now spent training his new pup Captain to hopefully reach the CARDA standard in the future.
20 WHISTLER'S 2019-20 PERSISTENT SLAB PROBLEM



front lines

20

WHISTLER'S 2019-20 PERSISTANT SLAB PROBLEM

in this **section**

// DANYELLE MAGNAN

A NEW SEASON MEANS IT'S TIME FOR TRAINING, BRUSHING UP ON SKILLS, AND LEARNING NEW ONES. // JENNIFER COULTER

Pre-Season Training Roundup

Every fall, as the first snowflakes of the season coat the ground, avalanche operations across Canada rev up and begin the process of pre-season training. While some aspects of training are likely common across the industry (think companion rescue and brushing up on snow profiles), each operation has unique needs, whether it is a heli-skiing company, ski resort, or consulting firm. We reached out to four organizations representing different sectors of the avalanche industry to see how they handled pre-season training and how it has evolved over time.

Training at **Dynamic Avalanche Consulting**

Chris Argue and Elaine Lajeunesse

AT DYNAMIC AVALANCHE CONSULTING, our training can be classified into three categories: general training, project orientation, and technical skills training.

General training includes tasks common to most aspects of our work such as winter driving, bear awareness (for summer field work), health and safety policy, and safe work procedures. This training may or may not be recurring, depending on the needs of individual workers and regulatory requirements.

Project orientations typically include a combination of training required by the client and site-specific procedures related to a given avalanche program. For example, BC Hydro requires all unsupervised workers accessing their sites to have electrical system safety training, whereas avalanche-specific program training may include a review of the avalanche terrain, rescue and first aid equipment caches, and study plot locations.

Training related to technical skills tends to be focused on critical skills required for a task. Our team members generally have a high level of experience and technical skill; consequently this training has been parsed down to specific items over the years. Examples of critical skills for our programs include explosive use, such as Avalauncher or helicopter bombing procedures, and crevasse rescue practice.

Mental health support is built into our health and safety policy. Examples include addiction support and critical incident management. However, in the past our training has not explicitly focused on mental health. The most closely related topic, which is a standard component of our general training, is fatigue management. This topic is particularly important for us as work days begin early and can exceed 12 hours. Fatigue management training emphasizes hourly maximums for work days and fosters open communication around workload management.

As our business evolves, we continue to develop our training programs to current needs and industry practices.

Avalanche Canada Incorporates Mental Health Into Training

Jennifer Coulter

THE AVALANCHE CANADA FORECASTERS AND FIELD TEAMS HAD TO ADAPT TO ONLINE TRAINING DUE TO THE PANDEMIC. // CONTRIBUTED BY AVALANCHE CANADA

AS OUR AVALANCHE CANADA TEAM GROWS, so too does our need for training that addresses some of our unique organizational challenges. Beyond our forecasters and roaming field team in Revelstoke, this winter we will boast full-time field teams in Vancouver Island, the Yukon, the Northwest Inland, the North Rockies, the South Rockies, and Newfoundland. With teams spread across the country, our annual fall training is a rare opportunity for us to spend time learning and growing together, be it virtually or in person. Avalanche Canada is an organization that cares about its employees' wellbeing, not just in the physical sense, but also when it comes to their emotional resilience. This year's training aims to reflect those values.

Traditionally, each fall we would host indoor sessions made up of thought-provoking professional development presentations, along with more standard sessions focused on safety and operations. With the disruption of COVID, we learned a lot about communicating with a dispersed workforce and are confident we can build engaging sessions that include new field team staff that would normally be unable to attend in person due to geography.

When the snow falls and the stoke rises, it is time for our outdoor training component. This takes place at each of our field team locations and involves staff and supervisor exchanges. Moving staff around ensures we get to know each other, cross-pollinate ideas, and promote consistency when it comes to our operational risk tolerance, field practices, and communication products.

Much of our fall training focuses on the tasks staff are expected to perform and how they can mitigate physical risks while doing so. This year we are continuing our investment in our staff's emotional wellbeing by inviting an expert with extensive knowledge of psychology and the avalanche industry to tailor a mental health and resilience workshop specific to our needs.

The potential for stress injuries after a major incident as an avalanche technician, guide, or ski patroller seems increasingly well accepted; many operations now have pre-planned mitigation strategies aimed at supporting workers. Perhaps less well understood are the challenges that may fall outside of a typical acute workplace incident. How do the heavy cognitive loads of a seasonal industry intersect with troubles at home? How does the cumulative trauma we carry from other jobs in the avalanche world combine with writing avalanche forecasts and feeling responsible for the public we serve? How do we prevent burnout and stress when it comes to managing social media communications when conversations move from topical to trolling? At training, with the support of our expert, we hope to work through some of these types of scenarios, with a focus on:

- Reducing and fighting stigma around mental health topics.
- Giving participants a common language to think and talk to each other about mental health.
- Developing the self-awareness required to identify poor mental health in ourselves and others.
- Giving staff strategies to manage stress and mental health challenges.
- Developing a relationship-centered peer-support network.
- Teaching staff about their rights and responsibilities when it comes to mental health.
- Understanding what resources are available through Avalanche Canada and the various communities where we work.

Our team is looking forward to a new season with more staff members providing more services to people living, working, and playing in avalanche terrain. This fall we will use virtual training to bridge distances and include all of our field team family. Staff training will be our first opportunity to use field team exchanges to promote a safe and productive workplace culture. Finally, with a continued commitment to mental health topics, we hope to make Avalanche Canada an employer that protects and promotes psychological health and safety so we can work hard and play hard for years to come.

Training Evolution at CMH

Erich Unterberger, Manager of Guiding Operations, CMH Heli-Skiing

CMH GUIDES PARTAKE IN PRE-SEASON RESCUE TRAINING. // CONTRIBUTED BY CMH

I CLEARLY REMEMBER THE FIRST guides training I attended with CMH in 1987. CMH was already a well-established heli-skiing company with Hans Gmoser firmly in charge. Leo Grillmair was managing the Bugaboos at the time and Kobi Wyss was the operations manager. The volume of content covered at training and the attention to detail was very impressive. I was a fairly new mountain guide from Austria and used to some rigorous training, but not to this extent. It included presentations from snow gods of the time, Ed Lachapelle and Peter Shearer. Hans, Leo, and other legendary guides were clearly eager to learn from them and asked lots of questions. Needless to say I was hooked and I am still here 34 years later.

The training was very much focused on avalanche rescue and snow evaluation, which was centered on stability at the time. The first evolution of our guides training that I witnessed came with the creation of the Mountain Safety Manager position. While some say this came as a result of the Bay Street avalanche, it was in fact planned prior. Jon Rudolf 'Colani' Bezzola worked tirelessly to incrementally improve on our safety. Guides training was a big part of achieving that.

This was also the time when Mark Kingsbury took over running the company. Mark was focused on guest experience and wanted to see more training on soft skills. One of the early attempts of that went sideways when Hans lost his temper on a stress management facilitator. But, being the classy man he was, he came around, apologized, and realized we needed to work in this direction. From then on, personal development included improving emotional intelligence.

Y2K did not end the world nor did it crash all computers. If anything, we got more access to information. This necessitated another adaptation for our operations and training for all guides. Guides training and the area set up will always have elements of improving on effective meetings while prioritizing and focusing on essential information.

CMH has been a test ground for safety equipment. The contributions from Rob Whelan working with Swiss engineers to help build the various Barryvox models is a great example of how mutually beneficial such cooperation can be. Intense beacon training is always part of both the guides training and area setup.

There is not enough space to name all the great facilitators of our training but I do have to mention a few who have been there consistently: Chris Stethem, Dr. Dave McLung, Dr. Bruce Jamieson, Dr. Pascal Haegeli, and, lately, Colin Zacharias. They deserve a huge thanks for their contribution to our training and their overall positive impact on avalanche safety.

Now we have 140 guides on the team. Sometimes we all get together for a conference-style training with electives for guides to choose from. When we do the training in our lodges, we split it up into three sessions. We come up with the content with input from all guides, the area managers, our mountain safety advisory group, and guest feedback.

Some components are in every training/setup and all of our guides are required to refresh their skills. We practice organized rope rescue and the improvised variety with lightweight gear. As mentioned previously, we practice advanced transceiver rescue, tree-well rescue, and shoveling skills. We train for avalanche rescue, which is often comprised of a complex scenario that tests both individual skills and our overall organizational response. We often do a group snow profile to help ensure we are all on the same page regarding snow observations and tests. We also cover everything from blasting to fueling a helicopter.

The training with all areas is 3.5 days long and each area setup is five days. The new guides get an additional two days of training prior, with a focus on getting them up to speed with our standard operating procedures.

I am truly honoured to be able to work with this elite group of mountain professionals. The collective wisdom present in any one of the training sessions is mindboggling; if only one could find an easy way to tap into it. Or maybe there is no easy way, one just has to spend the time, ask the right questions, listen and never stop learning.

Preparing For a Long Season at Lake Louise

Rocket Miller

LAKE LOUISE PATROLLERS AND A BOOT-PACKER GET INTO THE TERRAIN EARLY IN THE SEASON. // CONTRIBUTED BY LAKE LOUISE RESORT

FEW MOUNTAINS OPEN THEIR ALPINE terrain earlier in the season than Lake Louise.

Our crews are there every day and experience the evolution of the ski season from ground zero on the HS stake. The avalanche control team, forecasters, crew members, and mountain managers are in the terrain often before our pre-season training regime begins. Seasoned boot packers may be along in these times. These are folks who have an appetite for very early-season exposure to the slopes, generally have been on snow safety staff in the past, and are working to kill time and earn a season pass as compensation.

So, where and when does training get started?

One of the first things shared by our experienced staff is patience. Our season stretches to seven months and one must be careful to balance a work-to-ski ratio. There is certainly a conditioning period, particularly in the first two months as our staff get their legs. More importantly is the mental game, situational awareness, and coming to terms with what Mother Nature has provided and what we are able to alter.

Only those who have gained such experience and knowledge through previous training are included in the very early season. We will pause our efforts for our official training period, which generally starts in the last week of October (granted we opened on Oct. 29, 2020, this past season and Nov 1,,2019, the one previous).

While the snow safety department, which includes trail crew, ski patrol, and avalanche crews, focuses more on first aid, lift evacuation, and risk management, an avalanche component is included. An avalanche program overview is provided. Staff dedicated to the program are introduced, a typical day is related, explosives use is reviewed, and risk management such as daily openings, closings, and the communications of such, is explained.

Avalanche rescue and those processes are discussed; however, it is merely an introduction. It is not until mid-season, when we are fully open, that larger-scale rescue training occurs. Small-scale scenarios are conducted and include everyone in the snow safety department.

Each year or every other year, Parks Canada Visitor Safety will stage a large-scale rescue training exercise at the resort and include our staff. Other agencies such as the RCMP have used the resort as a training venue, and include our staff. In fact, they rely on our staff to create the scenario and take leadership roles, and they learn from it all.

While we are opening, we gradually introduce more personnel into the early-season program. These are generally second-year and beyond staff that have had a season or more at the resort and have a firm understanding of the seasonal processes. This is when training begins as far as gaining terrain and snowpack knowledge and experience.

Knowledge of the early-season and full-season processes starts with daily snow safety meetings every morning. Operational discussions include pertinent avalanche info. Weather and snow observations are shared, as well as expected terrain openings, potential openings, and sometimes potential closures. InfoEx and public bulletins are shared too. It then becomes radio chatter as one becomes more familiar with what is actually transpiring in the field.

When we have come to know our staff and what they are capable of, we include them in the field to gain experience. They are encouraged to gain backcountry experience on their own time. This becomes invaluable as they have to make their own decisions in the mountains.

Ultimately, our avalanche training is highly dependent on firsthand experiential learning with the help of mentorship and peer support. Hopefully, we all aspire for more training and the learning never truly ever ends.

Whistler's 2019-20 **Persistent Slab Problem**

Tim Haggerty

NATURAL AND EXPLOSIVES-TRIGGERED AVALANCHES IN WHISTLER'S WEST BOWL ON FEB. 1, 2020. THIS WAS THE LAST CYCLE ON A PERSISTENT WEAK LAYER THAT CHALLENGED THE RESORT'S SNOW SAFETY TEAM FOR SIX WEEKS THAT SEASON. // TIM HAGGERTY

INTRO

In the 2019-20 winter, Whistler Mountain experienced a 1-in-10-year weak layer that persisted in-bounds for six weeks in December and January. This article looks at how the snow safety team handled this PWL and the management plan the forecasters put in place to deal with the uncertainty surrounding it.

It looks at our AM and PM workflows and how we have developed them to encompass debiasing strategies, re-assessment, and reflection on an on-going basis. Lastly, we will cover how we communicated our concerns to management, our workers and our guests.

CONTEXT

Whistler Mountain makes up one half of Whistler Blackcomb (WB). Each mountain has separate patrol and avalanche programs, the main reason being the mountains' separate histories. Whistler opened in 1966 and Blackcomb in 1981, and they operated under separate owners until 1997. The second reason is the nature of the terrain on each mountain.

WB is located in the south part of the Coast Mountains in a transitional zone between coastal rainforest and the drier climate of the Cariboo-Chilcotin. It primarily has a maritime snowpack, but does receive continental influences such as Arctic outbreaks and extended dry spells. We operate 23 lifts that service all elevation bands, topping out at 2,180m. Our terrain atlas contains over 200 slide paths that can produce size two or greater avalanches, as well as many more micro features and terrain traps within our operating boundary.

UNIQUE CHALLENGES

WB has a long operating season with alpine lifts usually planned to open the first week of December and staying open until the end of May. Due to the size of our acreage and the guest volume, our operation runs 24 hours and various departments require access through avalanche terrain at all hours to prepare the slopes and lifts.

On Whistler we have up to 6.5km of cornices. Broad ridgelines and lee-facing bowls are accessed by all alpine lifts. Green and blue groomed ski slopes run parallel to

the cornices, providing guests with easy access to nature's elevator.

ELEMENTS AT RISK

Elements at risk to avalanche hazard on Whistler include workers, guests, structures, and our reputation.

Workers consist of two categories:

1. Avalanche workers: Patrollers with a minimum of CAA Level 1 certification who are involved with direct short-term hazard mitigation. They require further in-house training and personal protective equipment (beacon, shovel, probe, and airbag pack, all issued by WB).
2. Non-avalanche workers: These employees are allowed on designated routes through avalanche terrain and require the avalanche forecaster's permission to travel.

We control guest exposure by closing lifts that access the terrain when the existing avalanche hazard is greater than size one, while also closing avalanche signage and placing guards to keep uphill travellers out of our danger areas. Cornices are dealt with on an ongoing basis with explosives work. In addition, our grooming team pushes 1m vertical berms at the approach to some of these large cornices to deter people from approaching them.

We limit risk to the few lifts that are exposed to avalanche hazard with earthen deflector structures that decrease their vulnerability. We send teams out during large storms to perform control work to mitigate the avalanche destructive potential of these slide paths, reducing the impact pressures to the towers in the event they are hit, and decreasing the run out potential of any avalanches.

THE WINTER OF 2019-20

This was a below average season with 948cm total snowfall. The early season was warm but we managed to open on November 28—two weeks later than normal—with a snow depth of only 28cm at 1,650m. An Arctic outbreak in late November contributed to weakening the shallow snowpack and small amounts of incremental loading through mid-December had us pondering when the tipping point was going to arrive. We observed the first remote activity on this layer on Dec. 7, with the first large cycle on Dec. 21 and 22.

A near-record January brought 478cm of snow and 27 days of avalanche mitigation work along with it. The avalanche hazard rose to high or extreme for eight days during the beginning of the month, with multiple large natural and controlled avalanche cycles. The Peak Chair did not open until Jan. 14 due to the active PWL, one of the latest openings on record. The times we were able to open the high alpine lifts were brief lulls in the PWL activity and we were only opening in small spatial steps.

Finally, a warm, wet atmospheric river arrived at the end of January, dropping 108mm of precipitation in 36 hours, with 70mm of that falling as rain to 2,000m. This flushed out or bridged over our early-season snowpack weaknesses and the PWL went dormant.

February and March were cold, with light but consistent amounts of snow. The skiing was good and the stress and fatigue from the season were put to the back of our minds. We closed March 14 due to the global pandemic.

MANAGING UNCERTAINTY

Managing the uncertainty surrounding this PWL made us collaborate on a plan with Blackcomb and our other neighbours. This involved continually gathering evidence, timelines, and slope tracking, while operating with large safety margins to minimize or eliminate the exposure to staff and guests.

When gathering evidence, we relied on the strength of outlier events and weighted heavily the snow profile data that we were collecting daily. Even when there was a lack of direct evidence, we knew the facet/crust layer was lingering and it made us question the stability of the slopes we tested. This is what we deemed the "Rockies Mindset." We were trusting the "base rate" or, in other words, the terrain. If a path had snow on it in early December and could produce an avalanche, it was tested with explosives. Then it was re-tested whenever any new stress was added.

As for time considerations, we added an explicit 24 hour rule: after any significant result occurred or any new stress was added to the snowpack, every large slope was tested multiple times over several 24 hour periods. We used a helicopter to reduce exposure to avalanche workers on the ground and to place bigger charges of either 4kg of Emulex or 12.5kg ANFO bags. Time also allowed the snowpack to set up between mitigation efforts. A couple of cycles in January took four to five days of this routine before we could confidently open the terrain.

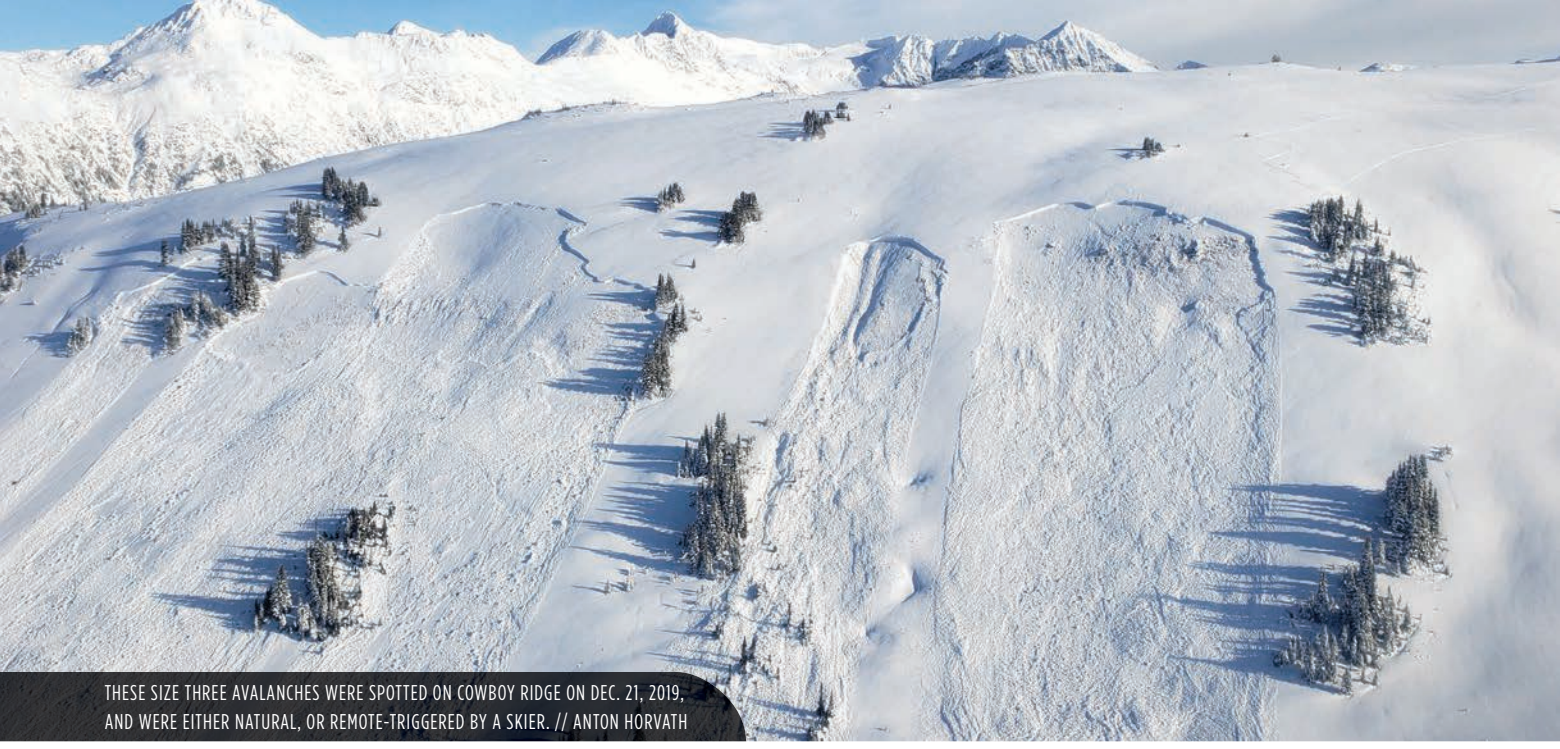
We tracked all slopes that released on InfoEx using the photo overlay extension and the freeform in the PWL assessment to write in slopes and dates when they released. We started ski packing our shallow easterly tree line terrain to break up the facet/crust layer—this is not a normal mitigation technique on the coast.

Large safety margins were implemented through the use of helicopter deployment and by limiting exposure to avalanche workers by restricting their travel in all alpine bowls. We used larger explosive charges in various trigger points to test all of our large alpine start zones. Alpine terrain remained closed for long periods of time during December and January.

DEBIASING, REFLECTION AND WORKFLOWS

Over the past couple of seasons our snow safety team has implemented debiasing strategies through our InfoEx workflows. With such a large team, coupled with the perceived and personal pressures, we are likely to be biased in our hazard and risk assessments.

To combat this, we need to recognize what are assumptions and what are facts. This helps to understand if our uncertainties fall outside of our risk tolerance and



THESE SIZE THREE AVALANCHES WERE SPOTTED ON COWBOY RIDGE ON DEC. 21, 2019, AND WERE EITHER NATURAL, OR REMOTE-TRIGGERED BY A SKIER. // ANTON HORVATH

directs us to question what is acceptable for the given avalanche problem.

In our AM workflow we ask ourselves:

1. Do the avalanche problems reflect the hazard rating?
2. Is our operational plan on par with our strategic mindset?

This puts reassessment into our morning discussion and hopes to add a rational discussion based on data and evidence as well as pattern recognition. This discussion takes place between the forecaster and the snow safety technician of the day to promote team decision making. We ask: "Is our intuition steering us wrong with our plan or our mindset?"

Reflection is done with any consequential decision, whether the outcome was good or bad. This helps us recognize patterns, which eventually leads to us being able to make better intuitive decisions in a fast-paced environment.

Our PM workflow discussion is built upon the CAA Level 2 PM form, but is tailored to our program's needs. It asks:

1. Were there any inconsistencies from the AM hazard and what were they? This catches trends and personal biases.
2. Were there any contributing human behaviors? This includes the forecasting team, management, workers, and guests. We include all pressures, near-misses, and influences on the program.
3. Was our operational plan appropriate? Were we operating within our operational risk band or were we too risky/conservative? Did we think how our decisions would affect the operation as a whole?

We stress debiasing and reflection in our snow safety program so that our team recognizes we are all fallible. Our goal is that honesty and humility will create a safer patrol culture through sharing our own mistakes.

COMMUNICATION

Communicating our concerns for this 1-in-10-year PWL was the hardest part. We were quick to remind management of the 2008-09 season, when two lives were lost in two days in terrain outside our operating boundary.

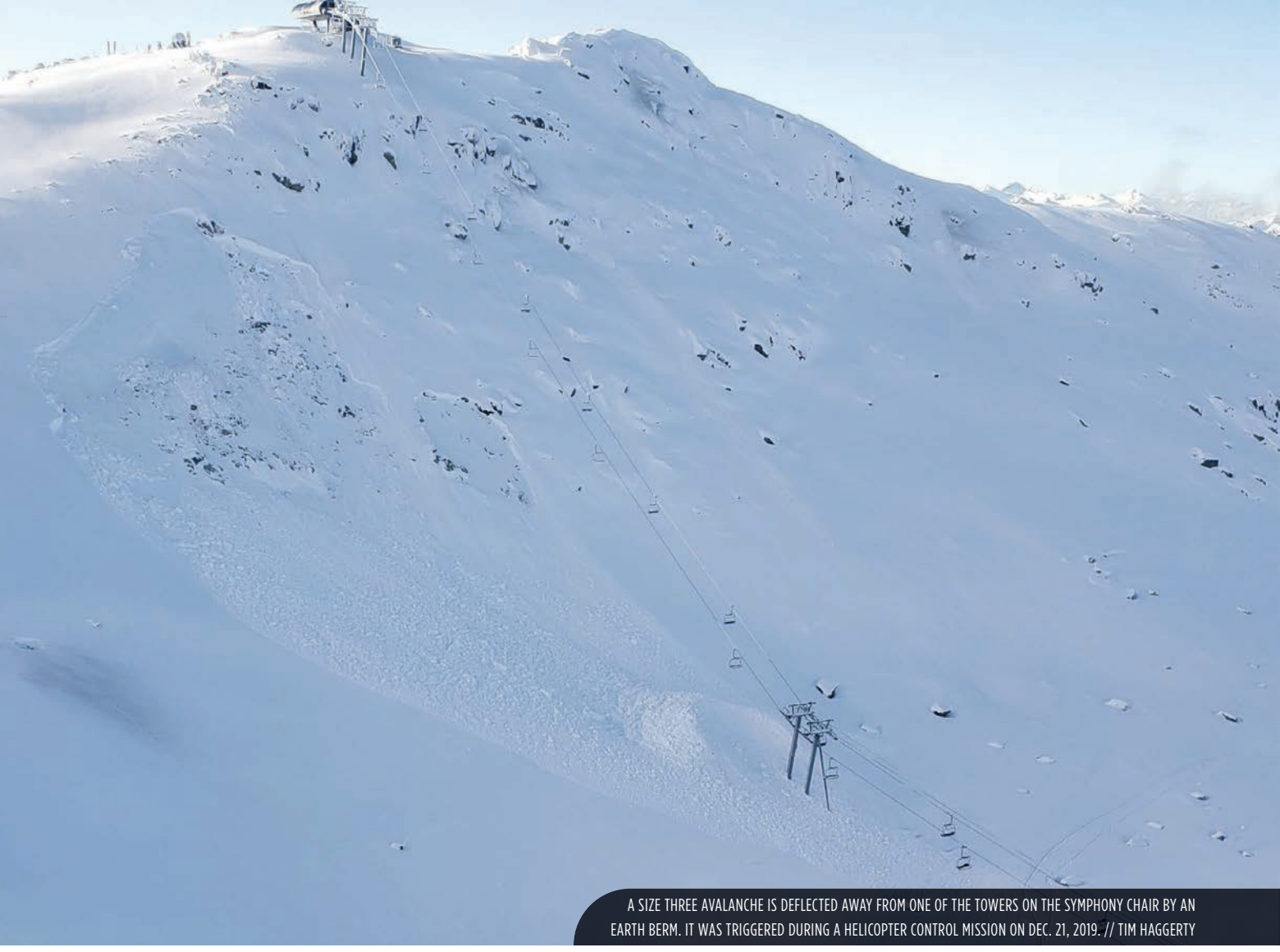
Our forecasters were able to recognize the severity of this PWL early in December. We were able to talk to upper management on a daily basis, providing strong and consistent evidence that we would not be able to open high alpine lifts safely by mid-December and that this layer could plague us into January. We laid out our plan and provided a cost/benefit analysis for working terrain hard versus just waiting for the snowpack to heal. We worked it hard on Whistler Mountain. At no time did our senior leadership team pressure us to open terrain or lifts.

During daily meetings with our patrol we described our uncertainty in spatial variability and the likelihood of triggering. We emphasized team decision making in the field and constantly discussed previous seasons' PWLs with route leaders in front of the group. We consistently communicated our large safety margins and reassured teams to slow down and that there was no operational pressure to open the terrain. With debiasing and reflection built into our workflows, we discussed these as a group in the AM briefing before avalanche control commenced.

A "Rockies Mindset" was encouraged and explained to the patrol and non-avalanche workers in regard to conservative decision making, terrain selection, and patience.

Communicating this to our guests was a different story. With such a dismal start to the season the public, was chomping at the bit. When the snow arrived, their coastal mindset of "If the ground is covered in snow it's good to go," kicked in. Poaching avalanche closures became a regular nuisance and a lack of natural activity and visibility was our worst enemy as the terrain remained closed. Skier accidentals and skier remotes were all too common in the closed terrain.

Our normal avalanche sign lines needed to be beefed up, often with guards or by closing buffer terrain. New for this season was our uphill travel policy, which was developed



A SIZE THREE AVALANCHE IS DEFLECTED AWAY FROM ONE OF THE TOWERS ON THE SYMPHONY CHAIR BY AN EARTH BERM. IT WAS TRIGGERED DURING A HELICOPTER CONTROL MISSION ON DEC. 21, 2019. // TIM HAGGERTY

to help control guests with touring gear from hiking inside our boundary. This limited guests to certain routes that were signed and open or closed based on lift access and avalanche closures. Once the public adjusted to the new written policy it was easier to communicate our concerns.

Avalanche Canada seemed to be on speed dial during the PWL cycles. We were able to provide them with strength and weight of evidence, as well as express our uncertainty in how long this PWL was going to remain reactive. This was our only public outlet; our company's media policy keeps our staff from being able to communicate on social media or through the news. Avalanche Canada did a great job of relaying our concerns with the persistence and the consequence of this layer. There were a few near-misses in the backcountry but no one died in the Sea-to-Sky from this layer.

SUMMARY

This PWL remained active for six weeks resulting in our high alpine lifts opening two to four weeks behind schedule. We conducted avalanche control with explosives 46 out of 76 days, with our season ending on March 14.

There was a lot of learning during the 2019-20 season:

1. Dealing with uncertainty and accepting patience as a tool to decrease it. By creating time in the morning workflow and by having a pre-plan with a few explicit rules, we were able to decrease pressure on the team by communicating these ideas.
2. Training. When we were not doing avalanche control, we trained. This included AvSAR response, companion rescue, and route training. This helped patrollers be more efficient and effective with their decisions and actions in the field while under stress.
3. Debiasing and reflection should be in everyone's workflows, professional and recreational. Be humble and honest with yourself and your team whether the outcome was good or bad.

Our forecasting team believes that running a safe, effective and efficient snow safety program is not just about snow science, but how we manage people in our terrain. Our program is extremely complex. By focusing on human behaviour, reflecting on our actions and decisions, and effectively communicating our concerns, we hope to be able to push for a safer mountain culture.

Persistent Problems on the Coast

Simon Horton

IN RECENT YEARS, Avalanche Canada has expanded the use of snowpack and weather models in our workflow. These models were originally intended to help in data-sparse regions, but they have also shown potential value in alerting forecasters about anomalous conditions and in debiasing perceptions about typical conditions.

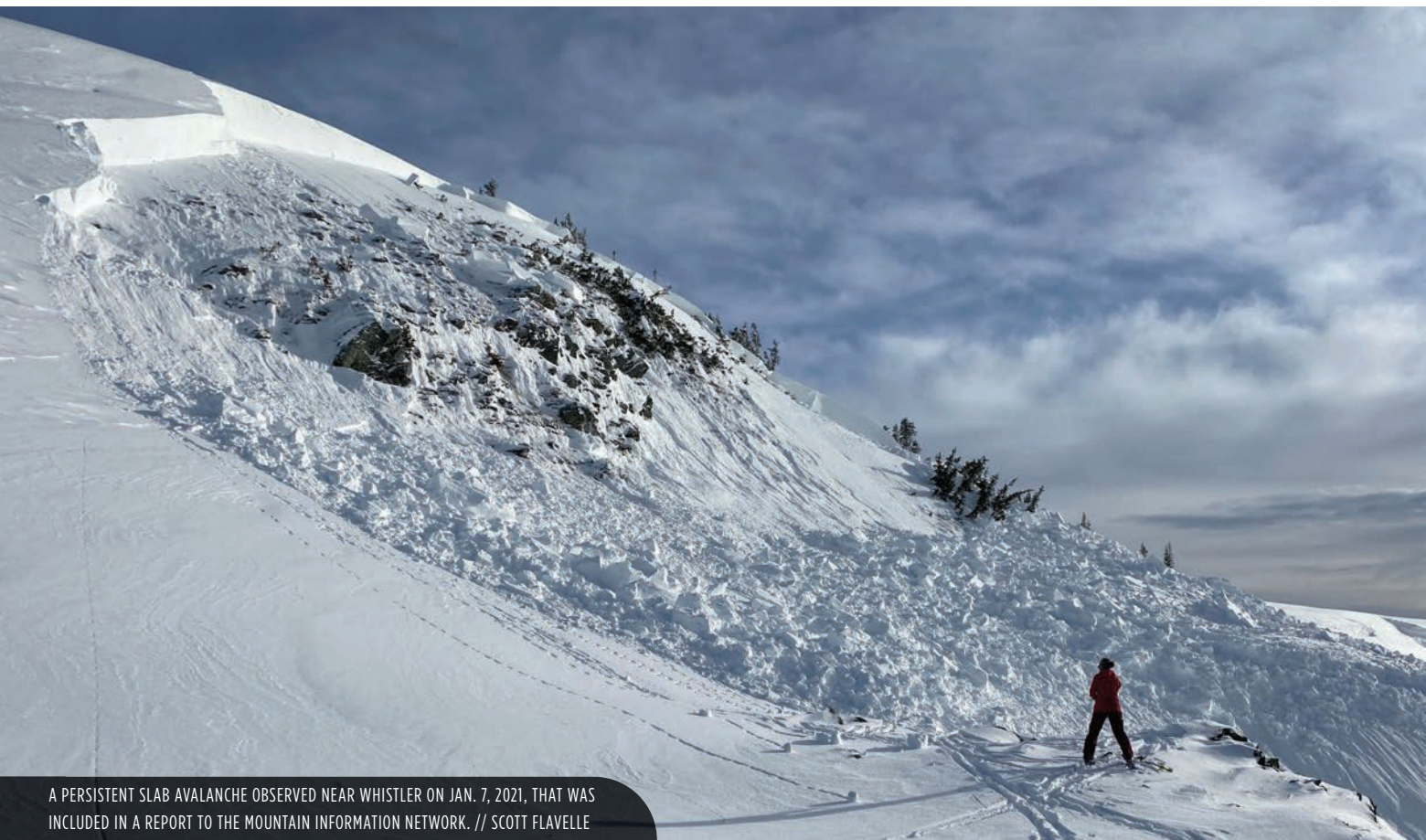
In recent years, these models have picked up several notable persistent weak layers in the southern Coast Mountains. While it is common to think persistent problems are less likely in the Coast Mountains, they have resulted in more fatal avalanches than any other type of avalanche problem over the past decade. This highlights the importance of forecasting coastal PWLs, as well as communicating and educating backcountry users about the distinct challenges they pose. This article looks at recent trends of PWLs on the coast and how snowpack models have succeeded and failed in detecting them.

RECENT PERSISTENT PROBLEMS ON THE COAST

It's common to make generalizations about how avalanche conditions on the BC coast ebb and flow with storm cycles and how persistent weak layers are uncommon. While this is true relative to the interior, perhaps we should be cautious about spreading this idea given recent accident trends.

Over the last 10 years, there have been a total of 18 fatalities in 13 different avalanches in the Sea-to-Sky, South Coast, and South Coast Inland forecast regions (Avalanche Canada, 2021). Based on the best available information, these included seven fatalities in six persistent slab avalanches, five fatalities in five storm or wind slab avalanches, and six fatalities in two cornice falls. Persistent slabs have been the most common problem type in fatal avalanches. Furthermore, there has been at least one fatal persistent slab avalanche in these regions in each of the last five winters. Shandro and Haegeli (2018) examined eight years of avalanche forecasts and found persistent problems were forecasted roughly 10-20% of the time in the south coast regions, and 20-40% of the time in the north coast regions.

While persistent slab problems are notorious for surprising people in all regions, there seems to be a distinct pattern of human-triggered avalanches during the onset of persistent problems on the coast. For example, this past winter the Sea-to-Sky region had a notable persistent problem for about five weeks, from Dec. 17 to Jan. 19, resulting from a combination of surface hoar, facet, and crust layers formed in early December. Regular avalanche activity was observed on



A PERSISTENT SLAB AVALANCHE OBSERVED NEAR WHISTLER ON JAN. 7, 2021, THAT WAS INCLUDED IN A REPORT TO THE MOUNTAIN INFORMATION NETWORK. // SCOTT FLAVELLE

these layers when they were initially buried during a stormy week leading up to Christmas. By Dec. 28, the weather had cleared and cooled, the weak layers had become less likely to trigger, and the danger rating dropped from considerable to moderate. But on this day, there were several notable accidents, including a fatal avalanche north of Pemberton. Similarly, when a facet/crust layer was buried later in January, there was a string of accidents in the North Shore, Vancouver Island, and Coquihalla Pass.

BIASES ABOUT COASTAL PWLS

The perception persistent weak layers are unusual on the coast poses some problems. First, it may lure recreationists into a false sense of security. The general wisdom in the coast backcountry community is that you can step out after a storm relatively aggressively, whereas the same terrain tends to be approached more cautiously in the interior.

Another problem is that forecasters may be quick to rule out the possibility of persistent slab problems. While in some cases they may have sufficient field observations to know about a developing weak layer, it's also common to make judgement calls about whether persistent layers have formed and whether they will survive the onslaught of a coastal storm. Personally, over the past five years of public forecasting, I have been surprised by a few developing PWLs and have started to give more conscious deliberation to forecasting persistent problems in these regions.

TRACKING PWLS WITH SNOWPACK MODELS

If the right weather conditions exist, persistent problems can develop in any mountain range at any time of the season. By analyzing recent weather patterns, snowpack models can make reasonable suggestions about when and where the right combination of a slab and weak layer may exist. For example, a clear calm humid night is just as likely to form surface hoar in the Tantalus Range as it is in the Valhallas even though surface hoar is much more common in the Valhallas. With the unknown impacts of climate change, we may experience more anomalous conditions that differ from our normal expectations for a given region.

Over the past few years, I have noticed several cases where the operational snowpack models implemented at Avalanche Canada have picked up on slabs above PWLs in the south coast regions (some models are available publicly at arfi.avalanche.ca). A standout event was in February 2019 when the models clearly showed a facet on crust layer in the North Shore mountains when a fatal avalanche occurred on Runner Peak.

This past winter, the snowpack model visualizations clearly showed the development and distribution of the facet and crust layer that impacted the North Shore and Vancouver Island in late January. During this period, field observations had confirmed a widespread persistent weak layer on the North Shore, but there had been very few reports from Vancouver Island. In this case, the model suggested

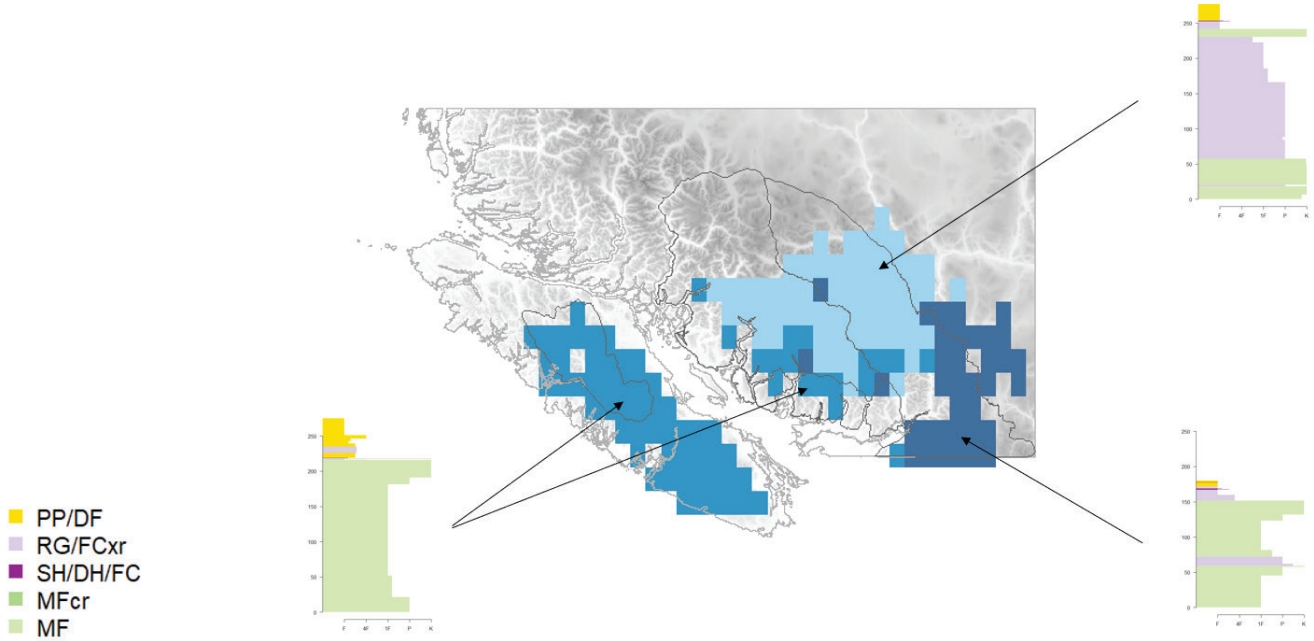


FIG. 1: SNOWPACK MODEL VISUALIZATIONS FROM JANUARY 31, 2021. THE THREE SHADES OF BLUE SHOW THREE DISTINCT SNOWPACK TYPES IN THE SOUTH COAST REGIONS. THE SNOWPACK TYPE ON VANCOUVER ISLAND AND COASTAL PARTS OF THE MAINLAND WAS CHARACTERIZED BY A SLAB OF NEW SNOW ABOVE A PERSISTENT WEAK LAYER ON A CRUST. INLAND AREAS ALSO HAD A CRUST AND WEAK LAYER, BUT MINIMAL SLAB DEVELOPMENT ABOVE THE WEAK LAYER. ON THIS DAY THERE WERE SEVERAL HUMAN TRIGGERED PERSISTENT SLAB AVALANCHES ON VANCOUVER ISLAND AND IN THE NORTH SHORE MOUNTAINS.

recent weather patterns were similar on the Island and therefore similar avalanche conditions could be expected, as was evident by several avalanche accidents. A week later the models showed the problem had resolved on the North Shore but had developed at Coquihalla Pass, again aligning with a string of incidents.

One has to be careful with models as they are not always correct (see Fig. 2). For example, the models did not accurately predict the persistent problem in the Sea-to-Sky region in December and January of last winter. To figure out what went wrong, we can look at the period when the PWL formed. In mid-December there was a short, clear cold period with about 10–20cm of dry snow sitting above a crust. The strong temperature gradients promoted surface hoar formation on the snow surface and faceting above the shallowly buried crust. The weather models, on the other hand, overcalled snowfall amounts and predicted 20–40cm of snow above the crust. This resulted in weaker temperature gradients and less faceting in the models, and resulted in them missing a critical snowpack layer.

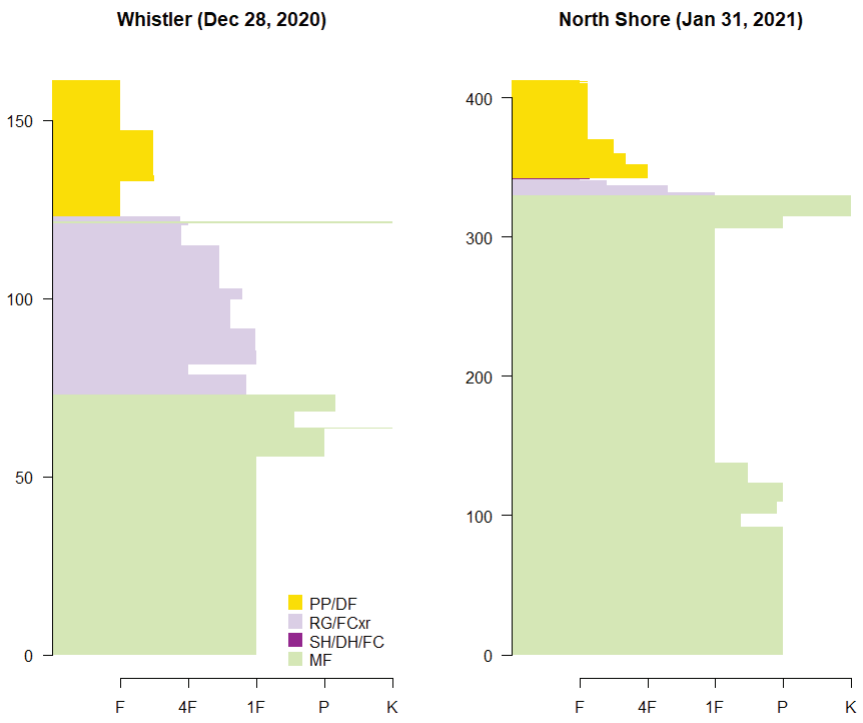


FIG. 2: THE SIMULATED SNOW PROFILE FROM WHISTLER ON DEC 28, 2020 (LEFT) IS MISSING THE PERSISTENT WEAK LAYER BENEATH THE NEW SNOW THAT RESULTED IN MANY AVALANCHE ACCIDENTS, WHILE THE PROFILE FROM THE NORTH SHORE ON JAN 31, 2021 CLEARLY SHOWS THE WEAK LAYER ABOVE A CRUST THAT ALSO RESULTED IN ACCIDENTS.

Overall, mistakes in the timing, location, and amount of snowfall are the biggest sources of error in snowpack models. Current research at SFU is looking into ways of improving the accuracy of the models, which is tricky since most areas have limited weather station coverage and irregular snowpack observations. The best path forward will likely be a combination of manual and automated corrections with carefully designed visualizations that show uncertainties.

CHALLENGING OUR BIASES

Over the past few years, I have found snowpack models helpful to prompt questions about potentially hazardous conditions. Whenever they suggest a persistent weak layer has formed, I have taken that as a prompt to investigate further, especially in coastal regions where they are less common. This usually involves scouring for supporting evidence in InfoEx and Mountain Information Network reports, and reaching out to people who have been in the field recently. An analogy is traveling in the backcountry without any evidence of instability. When you come across a piece of evidence that suggests a hazard may exist, it is generally weighted heavily regardless of the source. Models will inevitably make mistakes but when treated with curiosity and skepticism, they can offer a valuable independent data stream.

Recent accident trends don't tell us whether there have actually been more PWLs forming in the south coast regions over the past few years, but the fact there have been five straight winters with fatal accidents involving persistent weak layers is a trend worth keeping an eye on. If this trend is here to stay, we need to consider the potential implications in our forecasting practices as well as our education and communication to backcountry travellers.

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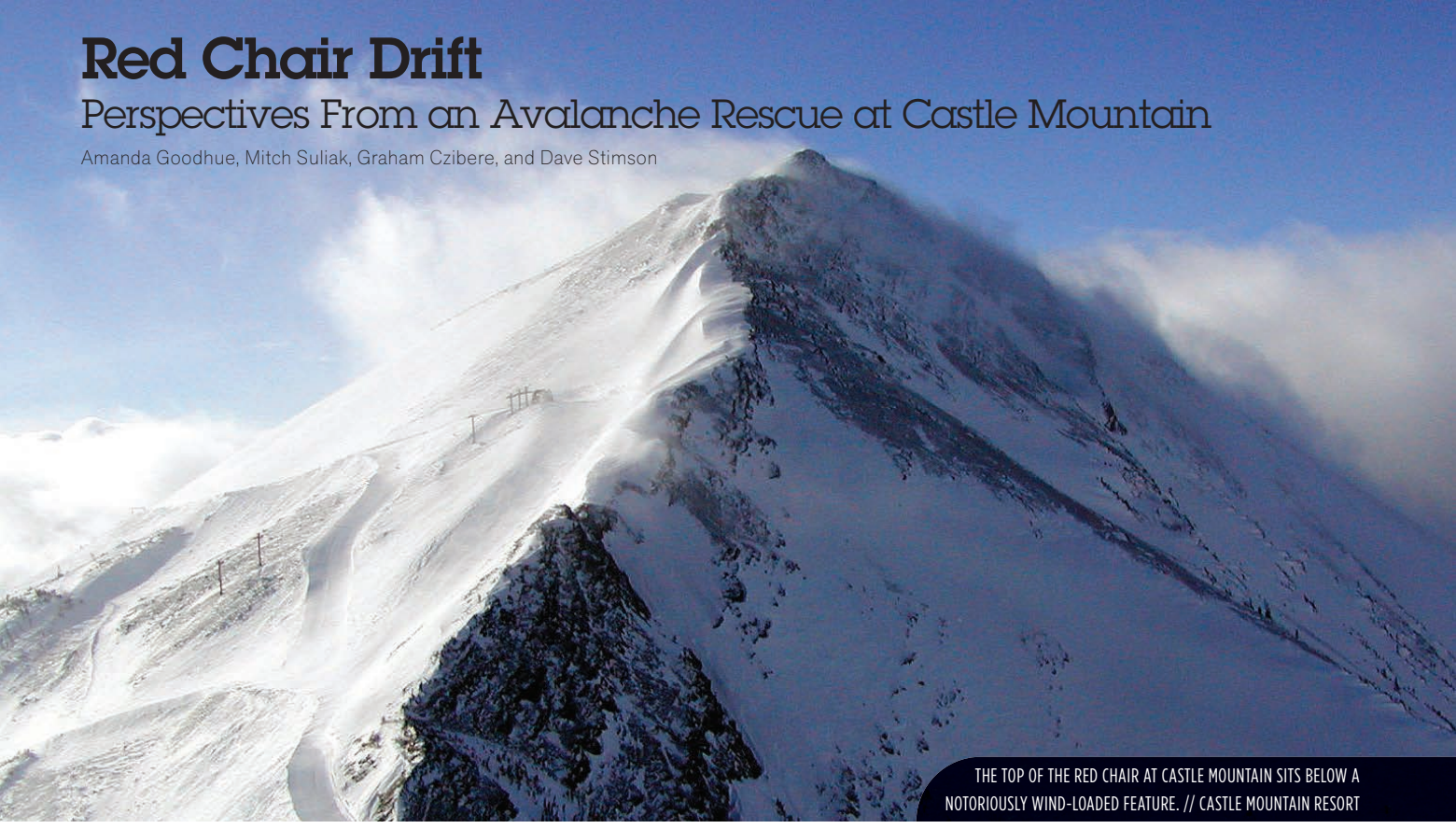
Red Chair Drift

Perspectives From an Avalanche Rescue at Castle Mountain

Amanda Goodhue, Mitch Suliak, Graham Czibere, and Dave Stimson



THE TOP OF THE RED CHAIR AT CASTLE MOUNTAIN SITS BELOW A NOTORIOUSLY WIND-LOADED FEATURE. // CASTLE MOUNTAIN RESORT

CASTLE MOUNTAIN RESORT IS LOCATED on the eastern slopes of the Rocky Mountains in southwest Alberta—an area notorious for its strong winds. Lingering above the aptly named Red Chair, a lift that accesses all the resort's alpine ski terrain, is an avalanche path called Red Chair Drift. This terrain feature loads rapidly during windy periods and poses a hazard for the lift unload area, which often acts as a terrain trap for any avalanches that occur. It also threatens infrastructure in the area, including the lift unload station, lift operator hut, and patrol hut. To mitigate this hazard our patrol team uses a number of different strategies, including explosives, ski cutting, and terracing with cat roads. The feature commonly produces avalanches up to size two with control work.

On February 15, 2019, an avalanche incident occurred on Red Chair Drift during operating hours. From our patrol hut at the top of Red Chair, a patroller saw someone side-stepping up the lower part of the feature, immediately triggering a size one avalanche that knocked them to the ground. A second, sympathetically triggered size 1.5 slide followed, fully burying this person and partially burying two others. The two patrollers in the hut quickly initiated a rescue response and determined one person was missing. Fortunately, all members of the public in the unload area were part of a local ski school, which made accounting for missing people easier.

A search was initiated using RECCO, but patrollers quickly realized there was too much interference from infrastructure and decided to immediately start a probe line with the bystanders on hand as they waited for more resources to arrive. Within a few minutes, one of the students got a probe strike 80cm deep. The victim was recovered within five minutes of the avalanche occurring and they were conscious, breathing, and had no injuries.

This is the account of the patrollers involved in the rescue.

MITCH SULIAK, FOURTH-YEAR PATROLLER

As I watched the snow settle around the Red Chair unload area, I could see two small girls poking out of the deposit, a halted chairlift, and a handful of bystanders scattered around. I called a Code Alpha into dispatch to activate the hill's avalanche response plan, confirmed skier involvement, and gave a few hurried details as Graham (Czibere) and I rushed to check on the two girls partially buried. Shocked and scared, but un-injured, I called on two bystanders to help uncover the girls while I stepped back and started going through the grocery list of resources we had at our disposal. Transceivers were unlikely and with the chairlift down, additional patrollers and our two onsite CARDA dogs would be delayed. The RECCO was worth a shot, but the resource we had the most of was people: roughly 10 youth aged nine to 16 and four adults—not my usual rescue team.

I called everyone together and explained to the kids that our best chance of finding their friend was to work together to search the avalanche debris with probes. I delivered one more hurried update to dispatch and set out to conduct a hasty RECCO search ahead of the line. The area of the deposit was small but oriented in a way that was difficult to eliminate interference from either the chairlift infrastructure or the probe line. After a short attempt I put

the RECCO away, updated dispatch, and committed to the idea that our best chance for a quick recovery was focusing our effort on working as efficiently as possible with our unlikely crew of rescuers.

GRAHAM CZIBERE, SECOND-YEAR PATROLLER

After Mitch deemed a RECCO search was going to be ineffective, we pivoted fully to a probe line. I returned to the patrol hut and looked for the probes. After taking a quick look inside the hut and not seeing any, I circled the exterior of the building. Once again, no probes.

As I let loose a slew of expletives, I re-investigated indoors and found them underneath a bench on the back wall. A wave of relief momentarily took hold as I threw the bench aside, grabbed the probes, and began doling them out to the awaiting public.

After a brief set of instructions we began searching the debris. There was some relief in the rhythm of the probe line as it was executed—the pattern of probing, stepping to a side, and repeating. Amidst the chaos of the scene the structure was comforting. I remember feeling this rhythm was dangerous as I felt myself falling into the pattern of simply trying to execute my own verbal instructions of accurate steps and probes. When I had this realization, I stopped the group to quickly reassert that everyone needed to remember to focus on our ultimate task. Accurate steps and probing was important, but they needed to notify us if they felt something unusual at the end of their probe. We restarted the line and within a couple of minutes we had a probe strike.

AMANDA GOODHUE, SECOND-YEAR FORECASTER

As I skied away from our patrol hut at the top of Red Chair to go assess the furthest reaches of our tenure, I stared up at Red Chair Drift. The wind had picked up and there was a lot of snow moving around. "I'll take a look at it again on my next lap," I thought.

My team had just entered our furthest terrain to start skiing down when a call came over the radio from Mitch: an avalanche had occurred on Red Chair Drift. There was little information, but from the tone in Mitch's voice I could tell he was concerned people may have been involved. I knew there was not much I could do to help on scene—I was about as far away as I could possibly be. As the lead forecaster for the day, I took the role of incident commander and started organizing resources to be sent their way.

By the time I got to the base area, we had snowmobiles, patrollers, and a CARDA team heading to the top of the mountain. At this point, I knew Mitch and Graham had their hands full on scene so I was trying to ask them as few questions as possible and still had limited information to work with. A radio call came in from Mitch: one person had been recovered and they were conscious, breathing, and had no injuries. They had good confirmation on scene that nobody else was missing but a search continued to clear the scene with probe lines and a CARDA team as I made my way back up the mountain. It took about 45 minutes to confirm there were no other burials from the time the avalanche occurred.

DAVE STIMSON, THIRD YEAR AS MOUNTAIN SAFETY MANAGER

I had just finished a great day of heli-skiing after a week-long drought. After 10 years of ski patrolling, I was beginning to explore other aspects of the industry in pursuit of an IFMGA certification.

MITCH SULIAK STANDS ON TOP OF AVALANCHE DEBRIS PRODUCED BY EXPLOSIVES CONTROL WORK ON RED CHAIR DRIFT. THE PHOTO DEMONSTRATES THE FEATURE'S POTENTIAL TO IMPACT LIFT INFRASTRUCTURE. // NATHAN PINCHAK

Connecting to the Wi-Fi back in the lodge, my phone downloaded a message from Amanda. It was long and detailed the guest-involved avalanche and the successful rescue. As the head of the snow safety program, my heart sank in a feeling of powerlessness as I sat 1,300km away. There was nothing I could do until I returned four days later.

I never envisioned myself running the ski patrol long term. In Canada, ski hill work seems viewed as a stepping stone towards guiding or industry work—the sexier or better paid jobs that make it easier to justify the seasonality of it all. I was no different. Through the 2010s, Castle suffered from high turnover within the patrol and in its leadership. In my first seven years, I had three different bosses and each time one left the whole patrol lost collective experience.

Recognizing my limitations upon taking over—both in experience and long-term motivation—we set out to build a more robust system for our avalanche forecasting that focused on mentoring new patrollers early and spreading the workload among more people. We moved towards a group dynamic that could better absorb losses of experience and no longer relied on one or two key people. Our weakness of high turnover became an opportunity to focus heavily on developing many patrollers that could hold up the program together.

AFTERMATH

There are a few things that contributed to a successful rescue at the top of Red Chair that day. First off, the avalanche occurred right outside the patrol hut so our response was immediate. Ongoing training and practice in avalanche rescue skills allowed the patrollers on scene to quickly and effectively come up with the best plan of action. Management of the probe line was also critical, especially in making sure students knew what they were feeling for with each probe strike. It was a student who got the initial probe strike and their ability to recognize that they had probed someone contributed to the successful rescue of the person buried.

As a patrol team, there were also some lessons to take away from this incident. With a less experienced forecast team working that day, we may have missed some of the signs that Red Chair Drift was loading faster than expected. We also may have put too much confidence in the cat road that was built across part of the feature as one of our mitigation strategies. The avalanche that occurred that day happened on the side of the feature where a road had not yet been built. The lessons learned and experiences lived that day have helped us continue to improve, both individually and as a team.

A PATROLLER CHECKS OUT THE RESULT OF EXPLOSIVES CONTROL WORK ON RED CHAIR DRIFT. THE FEATURE FREQUENTLY PRODUCES SIZE TWO AVALANCHES WITH CONTROL WORK. // BEN YEAGER

Applying the Strategic Mindset to Recreational Avalanche Courses

Colin Zacharias

THIS PAST JANUARY, *POWDER CLOUD* published *Terrain Tips #4: Know Where Not To Go*[1]. This was the fourth of five terrain articles I have written for the avalanche education site and arguably the most important. Its premise encourages the backcountry rider to conduct a pre-trip plan that emulates—in a simpler way—our professional hazard and risk analysis. To encourage a strategy of choosing terrain that reduces risk, the article highlights the two most important decisions backcountry riders make on any given day: 1) adopting a terrain mindset that reflects both an analysis of the risk factors and a willingness to limit exposure; and 2) agreeing on slopes to avoid (see Fig. 1).

As a part-time educator, I've worked with others developing curriculum for both the CAA and the American Institute of Avalanche Research and Education (AIARE). The latter specializes in developing recreational curriculum accompanied by yearly instructor training. During my tenure with AIARE we saw instructors readily adapt and engage students in field book trip-planning checklists, complete with prompts that promote teamwork, ensure consensus, reflect on goals and risk tolerance, preview terrain, identify route options and reduce exposure, and have an emergency plan. But while instructors employed Roger Atkins strategic mindset[2] at the workplace and on each American Avalanche Association professional avalanche course, there wasn't a lot of buy-in to apply it at the recreational learner level. Instructors preferred to keep the discussion to preferred and alternate routes that matched conditions, and offered a basic terrain narrative such as, "Avoid convex slopes and slopes over 30°," combined with ATES-style terms.

When trying to apply an Atkins-style mindset, most struggled to simplify what seems a little esoteric outside workplace operations. "What do you mean, 'strategic mindset' " This was a common student refrain echoed back to me by the instructors when we beta tested an early proposal. As a result, AIARE took several years of convincing prior to applying a terrain mindset to the daily trip plan. The initial preference was to avoid the mindset phrasing in favour of a "plan to limit exposure" similar to the ATES strategy. This meant previewing terrain at a drainage and mountain scale and describing the options available to reduce or eliminate exposure. For me, this line item of the daily trip plan worked, but this didn't quite provide the same decision making support that we had when we applied the strategic mindset in the workplace.

FIG. 1: THE FOUR KEY STAGES OF A PRE-TRIP PLAN, WITH THE TERRAIN SELECTION PROCESS IN #2 AND #3.

However, the idea of applying Atkins' mindset to the recreational course never went away. Paul Rogers, publisher and Editor-in-Chief at *Powder Cloud*, encouraged us on several occasions to find ways to better apply the concept to the Level 1 student (the U.S. equivalent of Avalanche Canada's AST 1). He and others recognized the mindset was more than a plan to limit exposure. In *Terrain Tips #4*,

[1]https://thepowdercloud.com/learn/avalanche-education/terrain-tips-no-4-know-where-not-to-go/
[2]https://arc.lib.montana.edu/snow-science/objects/ISSW14_paper_O9.02.pdf

ADOPT A TERRAIN MINDSET
CHOOSE *ONE* MINDSET FOR TODAY

Mindset	Team attitude prior to selecting your route
Check it out	**Observe but avoid today's avalanche problem** • We have low familiarity and confidence in either the terrain or our team, and/or we have high confidence that the conditions are dangerous. • Our goal today is to increase our confidence through careful, targeted observations without exposing ourselves to avalanche risk. • We agree to select a zone that offers several options to eliminate exposure to avalanche terrain. Our choices include low-angle and primarily forested terrain. We agree to avoid big overhead slopes, and on days with higher avalanche hazard, we also agree to avoid or minimize the risk of travel through runout zones.
Keep it mellow	**Limit exposure by avoiding steeper slopes, wind loaded start zones, and trigger zones** • We have moderate confidence in both our assessment of the hazard and our team's skills and knowledge. We can identify the avalanche problems and uncertainties that may cause issues. • We will create a plan with a range of options that allow us to gather relevant information while maintaining a large margin for error. We are hyper-aware that good decision making is paramount to avoid avalanches big enough to injure, bury, or kill. • We know that managing exposure requires experience and plan to select a zone where options exist to reduce exposure with careful route finding. When the avalanche problems are difficult to target, we will choose slopes <30o, avoid overhead hazards and terrain traps. Also, we plan to employ travel techniques such as spacing, timing, and strategic regrouping that further reduces risk.
Step it up	**Consider steeper options mindfully during periods when human and naturally triggered avalanches are neither expected nor reported** • We have relatively high confidence in our assessment of the terrain, conditions, and team members, and we have the training and experience to make good terrain decisions in this familiar situation. • This mindset assumes a low chance of avalanches, with no persistent slab or wind slab problems. We are aware that these factors, combined with a forecast for good visibility, are fundamental to managing avalanche risk on steep, open terrain, and on complex terrain with multiple avalanche slopes and terrain traps. We know this type of terrain may have limited options to reduce exposure once committed. • Our team members agree that it is appropriate today to venture out into more exposed avalanche terrain. We are mindful of the potential consequences that comes with increased exposure and we are prepared to back off and/or use alternative terrain options.
Time it early	**Prior to incoming storms or during spring-like conditions, travel when the hazard is low** • We anticipate low hazard early, but that conditions will significantly deteriorate during the day. • Our plan considers that rain or radiation/warm temperatures—and alternatively incoming snowfall and wind—can quickly increase the hazard and result in unstable snow. • We recognize that it can be complex to predict the interaction between weather and mountain slopes. We agree to build in a margin of error by starting early and returning early, and be out of harm's way with time to spare.

FIG. 2: THE FOUR MINDSETS. ©COLIN ZACHARIAS AND POWDER CLOUD.

I described why mechanized guides have always applied some sort of mindset when choosing and describing their terrain use strategy:

> *After reviewing weather, snowpack, and avalanche hazard factors, it was apparent that most guides would already have a morning mindset that would frame the team run-list discussion and operational plan.*
> *This mindset was a mental attitude or disposition that would evolve from each guide's hazard assessment, local knowledge, and personal level of risk acceptance. The mindset defined an unspoken, internal dialogue that illustrated each guide's perception of conditions, terrain, and level of uncertainty and confidence. "Today, I'm a bit uncomfortable. I'm choosing a drainage with straightforward options, keeping it mellow, and staying out of harm's way."*
> *Importantly, the mindset informed our team's decision to open or close ski runs and helped to subdue habit and desire—two semi-automatic processes that could bias our daily terrain choices. (Even prior to Atkin's terms each guide had a personal—and at times cryptic way—of expressing their mindset (and terrain-use strategy). A phrase such as, "Now is not the time to roll the dice," might reflect uncertainty. "Drop off low and pick up high," may indicate one's strategy to manage poor visibility and high freezing levels. "Stay on line only," could mean to only ski the most conservative, risk-free runs in each drainage. "Take a look, but take it easy," could urge a plan to get the guests out for a few safe runs, make some important observations, and come home early.*

As pros, when we agree that we are "stepping back"—to use Atkins' term— it doesn't only help define our terrain choices prior to departure, it also serves as a mnemonic device that carries our pre-trip choices into the field and supports each decision we make that day. This simple strategy may be missing from the recreational decision-maker's daily checklist. The moniker "stepping back" heightens our situational awareness and promotes team field discussion.

We knew it was important to somehow translate this essential decision-making tool to the recreational learner. We followed a few key strategies to better apply the mindset to the backcountry user's daily trip plan:

1. To be consistent, we wanted to come up with a set of similar terms and definitions that were self-defining, that reflected both the users analysis of conditions and terrain use strategy, and that was simple enough to apply. We agreed to keep it to four mindset options. Howie Schwartz, Bruce Jamieson, and I brainstormed and edited a number of versions. Paul Rogers, Brian Lazar, and Terry Palechuk also provided key input.
2. The application of a terrain use mindset had to be an integral part of a four- or five-step pre-trip plan. We didn't want it to be a literary sidebar (see Fig. 1).
3. Each mindset describes today's preferred plan. For example "time it early," identifies today's most suitable strategy. The accompanying one sentence descriptor in bold type provides a key message that defines how you reduce your risk: "Prior to incoming storms or during spring-like conditions, travel when the hazard is low." We felt that the mindset and brief descriptor would be memorable even if the bulleted paragraphs describing related conditions and uncertainties were not. Importantly, these defining paragraphs employ language that encourages consensus. (i.e. "We agree to build in a margin of error by starting early and returning early, and be out of harm's way with time to spare.")
4. Make the trip plan available at thepowdercloud.com for the 2021-2022 season, and ensure it includes an offline function. The 2021 publication of *Avalanche Craft* by Jamieson and Palechuk employs the same trip plan steps and mindset terms. The goal is to provide a simpler trip planning checklist that will develop into a post-course habit.
5. Test drive the strategy and incorporate feedback. Schwartz, Palechuk, and myself all had the opportunity to test drive the strategy with recreational learners prior to publishing the final version.

During the day-end debrief students can review the decisions made relative to the mindset they adopted. Importantly this informs how the student uses the mindset on subsequent days. Adopting a mindset prior to selecting a drainage, routes, and slopes has become an essential decision-making support tool and should be a part of recreational level curricula.

ACKNOWLEDGEMENTS

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Education-specific Extension
For Use With Strategic Mindsets

Steve Conger

ALIGNMENT OF DESIRES in avalanche terrain must include additional considerations when avalanche education is an objective.

The education extension intentionally combines goals of Roger Atkins' strategic mindset by establishing a background context, deliberate debiasing, and communication strategies. It invokes self-awareness by the instructor about their desires for a particular field day and the avalanche education setting in general. The extension is meant to be used in conjunction with the terrain or strategic mindset during pre-field trip planning.

There is a common thread in the four education extensions. Opportunities for misstep (student or instructor) are connected to the choice of destination and route. Destination and route are selected:

a) For a semi-stationary exposure period and to minimize learning roadblocks such as cold or over-exertion; and to maximize available time on site; OR,
b) To inherently provide adequate margin from consequential exposure during practice of skills with any avalanche terrain being observable/viewable/verifiable in the field without the need to be exposed; OR,
c) From alternatives providing appropriate validation simulation without immediate threat of hazard in case of misstep; OR,
d) Where direct supervision and established protocols are compulsory.

Mindset Extension for Education	Description	Opportunity for Miss-step	Strategy
Instructional	The learning objective requires skill or knowledge, typically with adherence to a set of guidelines or standards. Demonstration, practice, and repetition occur while semi-stationary.	Here an opportunity for misstep would be in skill practice such as poor craftsmanship or misreading a compass.	A lot of location planning results in minimal location assessment during travel by the instructor. Destination is chosen for extended exposure period. Route is chosen to minimize learning roadblocks and maximize available field lesson time.
Dry-run	The learning objective is met through coaching of a students' practice or feedback on demonstration of intellectual or physical skill.	Opportunities are limited or restricted to minor consequences through robust terrain margins.	Destination and route are chosen pre-trip to meet specific learning objectives and to inherently provide restriction to exposure. Avalanche terrain where the class might be exposed is observable and verifiable regardless of conditions. Terrain assessment exercises can occur without the need to be exposed.
Validation	Intellectual or physical skills are confirmed or assessed through monitoring in a simulated situation or scenario.	Real or simulated opportunity for misstep without the immediate threat of hazard.	Destination and route provide appropriate scenarios or simulated situations that vary based on the curriculum and course objectives. Opportunities for misstep are identified by instructors as part of their planning to ensure the group is managed such that the instructor can step in at any time.
Practicum	A student has the mentored opportunity to practice skills in a real-world environment and conditions.	Same opportunity for misstep and same consequence as real life situations.	Under Practicum, a student applies skills under direct supervision of an appropriately competent mentor in a highly structured relationship using established protocols and skill expectations. Established protocols might be organization or sector standards, desired learning outcomes described in a curriculum, or specific skill expectations.

The education mindset extension can serve as a tool to assist an instructor in applying the CAA Guidelines for Instruction in Avalanche Terrain.

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EVALUATING FORCES FOR EXTENDED COLUMN AND COMPRESSION TESTS

in this **section**

// LYLE GRISEDALE

How Precise Do People Think the Aspect Information Is?

Pascal Haegeli and the SARP Research Team

EFFECTIVE COMMUNICATION DEPENDS critically on the sender and the receiver having a shared understanding of the meaning of the words or graphics that are used to exchange information. This is generally not a problem in every day face-to-face conversations where we can correct a misunderstanding right away. I seem to re-explain myself with, "This is not exactly what I meant to say. Let me explain this differently," fairly frequently. However, establishing this common understanding is extremely important for more technical information exchanges, especially when they are not face-to-face and we cannot follow-up right away. This is why the *Observation Guidelines and Recording Standards (OGRS)* is such an important document for the avalanche community.

Establishing this common language is more difficult in public avalanche risk communication, where forecast users do not need to take a course before they start using the bulletin even though some of the shared information is quite complex. Meanwhile, forecasters only get limited feedback on whether bulletin users interpret the posted information in the way it was intended to.

When designing our 2020 survey on the presentation of avalanche problem information, we were curious to learn more about peoples' perceptions of the precision of the avalanche problem location information. As avalanche professionals, we know that when the bulletin talks about wind slabs on northwesterly to easterly aspects in the alpine, that this is just a general guideline and that it is still possible to find wind slabs on other aspects. But how do recreationists look at this information? Do they also know the information in the bulletin provides just a rough indication of where the wind slabs are most prevalent, or do they think they only need to be concerned about wind slabs on these particular aspects and everywhere else things are fine?

THE SETUP OF THE QUESTION AND ANALYSIS

After exploring a lot of different ideas for tackling this question, we came up with the following approach. The basic idea was to present participants with the aspect and elevation information of an avalanche problem and ask them to express their level of surprise about seeing evidence of related avalanche activity outside of the specified locations (Fig. 1). Our thinking was that the more precise you think the information is, the higher your level of surprise when you find evidence of avalanche activity outside of the specified aspect range.

Figure 1 shows the setup of our survey question, with the location of the wind slab avalanche problem shown with graphics similar to the ones used in Canadian avalanche

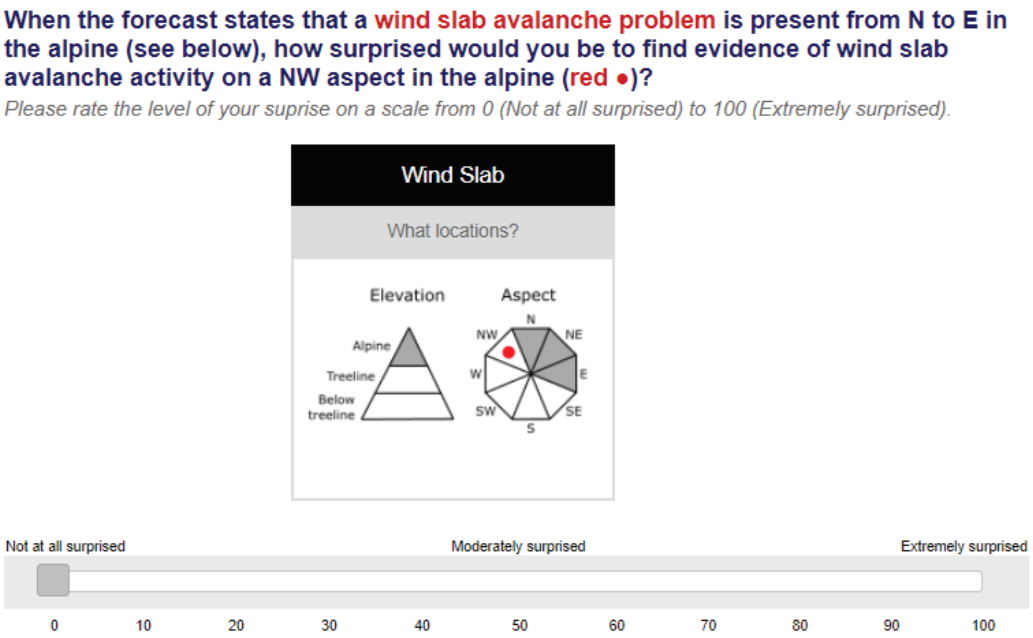

FIG. 1: EXAMPLE SURVEY QUESTION EXAMINING THE PERCEIVED PRECISION OF THE ASPECT INFORMATION OF AVALANCHE PROBLEMS (SCENARIO: WIND SLAB, ADJACENT).

forecasts. The red dot indicates the aspect with the observed avalanche activity, and the slider at the bottom allowed participants to express their surprise on a scale from 0 (not at all surprised) to 100 (extremely surprised).

To explore whether the perceived precision of the information differs between avalanche problem types, we included wind slab and wet loose avalanche scenarios in our experiment. Both of these problems are typically more prevalent on certain aspects—wind slabs on lee slopes and wet loose avalanches on southerly and westerly slopes that get full sun in the afternoon—but wind slabs are more likely to also be present on other aspects as the winds are heavily influenced by the local topography. We wanted to know whether our survey participants understood this subtlety.

In addition, we wanted to see whether the distance from the specified aspect range made a difference. In other words, did the level of surprise differ if the observed evidence of avalanche activity was immediately adjacent to the specified aspects or farther away.

To properly isolate the effect of avalanche problem type and aspect distance in our analysis, we had four different versions of our survey question. Each problem had one version where the evidence of avalanche activity was immediately adjacent to the specified aspect range (as shown in Fig. 1) and a second version where the aspect was one segment further away. Each participant was presented with a scenario from each avalanche problem type, and we randomly picked whether or not the avalanche activity was immediately adjacent to the specified range or farther away.

Overall, 3,236 survey participants answered our surprise question. Roughly one third were Canadian while the rest were American. Our sample included a wide range of training levels. Almost half had completed an introductory avalanche awareness course (e.g., AST 1), and the other half was fairly evenly split between no training, advanced recreational training, or professional training.

The goal of my statistical analysis was two-fold. First, I was simply curious to see how surprised participants said they were and how that differed among the various combinations of avalanche problem type and aspect distance. The second goal was to find out whether participants' background characteristics had a significant effect on their level of surprise. I considered age category, self-identified gender, country of residence, level of formal avalanche training, years of winter backcountry experience, number of days recreating in the backcountry each winter, and the avalanche bulletin user type that Anne St. Clair introduced two years ago (St Clair et al, 2020).[1]

THE DETAILED RESULTS

To analyze this dataset, I used a beta regression and a conditional inference tree. While both analyses revealed similar patterns, I will focus on the results from the latter as it comes with a nice visualization that makes the results much more approachable. The results are illustrated in Fig. 2. The tree structure highlights which of the included scenarios and participant characteristics have a statistically significant relationship with the level of surprise that participants expressed. The box plots at the bottom summarize participants' surprise ratings for a specific segment of the sample. For example, the box plot on the far left summarizes the surprise ratings of participants with no or recreational avalanche awareness training for wet loose avalanche activity in the aspect segment immediately adjacent to the specified aspect range. The grey boxes represent the central 50% of the surprise ratings and the horizontal black bar shows the median. The whiskers indicate the normal range of the data and the dots are data points that are considered outliers.

Overall, our analysis revealed that the characteristics of the scenario (shown in yellow and orange) play a much bigger role in participants' surprise ratings than their backgrounds (shown in blues and greens). The variable at the very top of the tree—and therefore the most important variable—was how close the evidence of avalanche activity (i.e., the red dot) was to the aspect range specified for the avalanche problem. Overall, the average surprise rating was 30 out of 100 when the avalanche activity was directly adjacent to the specified range, while it was 53 out of 100 in the situation where it was one aspect segment farther over.

At the next level we have avalanche problem type, which was responsible for the next split on both sides of the tree. On the 'adjacent branch' on the left, the average surprise rating for the wet loose avalanche problem was 34, whereas it was 25 for the wind slab avalanche problem. On the other side of the tree, the average ratings were 57 and 47 for the wet loose and wind slab avalanche problems respectively. This means our sample as a whole was more surprised about the evidence of wet loose avalanche activity outside of the specified aspect range than wind slab avalanche activity. While this is what we expected, it is worth noticing that the effect is much smaller than the effect of the aspect distance. The difference in average surprise ratings was two-and-a-half times larger for the aspect distance than the avalanche problem type (23 versus approx. 10). Furthermore, the difference in surprise ratings between the two problem types did not change with

[1]In addition, I included a variable for the presentation format of the aspect and elevation information in the analysis to control for the fact that we used three different graphics. The Canadian style with separate graphics for aspect and elevation information (see Fig. 1), the US style aspect-elevation rose, and a slight modified aspect-elevation rose where all segments were of equal size. However, it turns out that the presentation format did affect the surprise level at all.

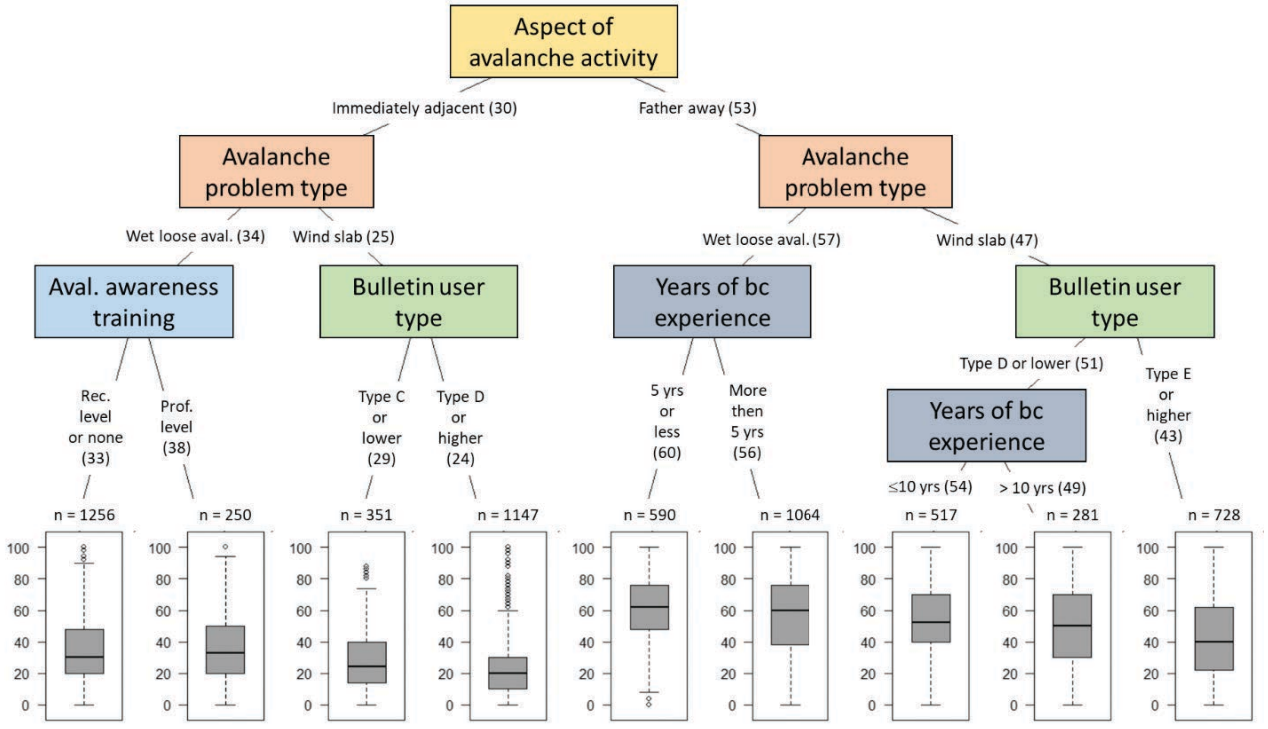

FIG. 2: CONDITIONAL INFERENCE TREE FOR SURPRISE RATINGS WITH SCENARIO CHARACTERISTICS (YELLOW AND ORANGE) AND PARTICIPANT CHARACTERISTICS (BLUES AND GREENS). THE NUMBERS IN BRACKETS INDICATE AVERAGE RATINGS.

the increasing aspect distance, which is different from what I imagined. I expected the surprise for a wet loose avalanche on a northeastern slope to be even higher.

However, the next level of nodes shows there is more nuance to this and that different people in our sample look at this differently. For the 'adjacent branch' on the left, avalanche awareness training further splits the wet loose avalanche problem node. Here, the algorithm revealed participants with professional level training (e.g. Avalanche Operations Level 1 or higher) expressed a higher level of surprise than the less trained participants (average ratings: 38 versus 33). In the wind slab node, the split occurred between Type C bulletin users, who mainly rely on the danger rating for their decisions, and Type Ds, who integrate avalanche problem information. Survey participants self-identifying as Type C or lower expressed a significantly higher level of surprise for the wind slab avalanche on the adjacent aspect than participants identifying with Type D or higher (average values: 29 versus 24).

In the right branch of the tree, where avalanche activity was farther away, a combination of years of backcountry experience and bulletin user type affected participants' surprise level. In the case of the wet loose avalanche activity, participants with more than five years of backcountry experience showed a lower level of surprise than the people with less experience (average ratings: 56 versus 60). In the wind slab branch, bulletin user type was the primary splitter, followed by years of experience. In this situation, self-identifying Type E bulletin users, who use the bulletin as a starting point for their risk management process and complement it with their own observations to localize and validate the information, gave the lowest surprise ratings (average value: 43). The branch with Type Ds or lower is further split into those with more or less than 10 years of experience. Here, participants with more experience expressed a significantly lower level of surprise than those with less (average rating: 49 versus 54).

THE INTERPRETATION

Now, what does it all mean? Here is how I look at it. In general, the results emerged as expected: people are more surprised with avalanche activity farther away from the specified aspect range, and they are more surprised about wet loose avalanches in unexpected places than wind slab avalanches. This seems straightforward. My only personal reservation is that I would have expected the difference between the two avalanche problems to be bigger and the effect of the aspect difference to be smaller for the wind slab avalanche problem.

The patterns in the variables describing the personal characteristics of participants indicate the level of surprise generally decreases with higher levels of training, years of experience, and a more sophisticated use of the bulletin. In other words, people's expectation about the precision of the aspect information comes down as they become more mature backcountry users.

While I do not want to over-interpret these results, I think they offer some interesting insight. A few years of experience

in the backcountry might make people realize that the aspect and elevation is generally not as precise as they originally thought. This general pattern is illustrated in the wet loose avalanche node in the right branch of the tree. People's understanding that the locations of wind slab avalanches are more variable and harder to pinpoint seems to evolve as they progress through their backcountry career. It seems that it takes a Type C bulletin user to realize that wind slabs on adjacent aspects are more common than previously thought, but it takes more than 10 years of experience and a Type D bulletin user to reduce their level of surprise for wind slabs on more distant aspects as well.

The pattern for wet loose avalanche problems on adjacent aspects is interesting as it points in the opposite direction. Here, it takes at least professional level training for people to understand that wet loose avalanches are quite aspect specific and having a wet loose avalanche on an adjacent aspect but outside of the traditional solar aspects might be more surprising than initially thought.

WHO ARE THE MOST SURPRISED?

Looking at all the box plots made me wonder who the people are that rated their surprise extremely high in any of the provided scenarios. This might provide an additional perspective on who has unrealistic expectations about the precision of the avalanche problem aspect information. To examine this question, I flagged all survey participants who rated their level of surprise at 80 or higher in at least one of their questions. A total of 607 survey participants, 19% of the entire sample, were flagged this way. To better understand who they are, I ran another conditional inference tree analysis relating the extreme surprise flag to the same participant characteristics that were include in the previous analysis. Interestingly, the analysis only revealed a single split based on bulletin user type. The percentage of participants with the extreme surprise flag was significantly higher among self-identified Type Cs or lower (24%) than among higher-level bulletin users (17%). While this is not a huge difference, it still indicates that lower-level bulletin users might tend to misunderstand the precision of the location information of avalanche problems.

While I might be pushing the results a little bit, I find it fascinating to think about how different segments of our user population read the bulletin information and integrate it in their avalanche risk management process. Having a better understanding of their expectations, perceptions, and practices will help us adjust our perspectives of what is useful and will eventually make better products. This short analysis definitely does not answer our big questions, but I hope it adds a small puzzle piece towards a better understanding of our users. As a follow-up, I think it would be fascinating to survey forecasters about their perspective on the avalanche problem location information and see how it lines up—or does not line up—with the user perspective.

If you have any comments or suggestions for new questions and analyses, please get in touch with me and share your ideas. We are always looking for new inspirations.

RECENT SARP ARTICLES ON OUR SOCIAL SCIENCE RESEARCH ON AVALANCHE BULLETIN USERS

Finn, H., St. Clair, A., Haegeli, P., Klassen, K., Clayton, M., and Gregory, R. (2020). Do recreationists have the skills they need to use avalanche bulletins effectively? The Avalanche Journal, 124, 32-34.

Haegeli, P. and SARP Research Team (2021). How is avalanche problem information used? The Avalanche Journal, 126, 36-38

St. Clair, A. Finn, H., Haegeli, P., Klassen, K., and Gregory, R. (2020). How getting to know the recreational audience can improve the effectiveness of the avalanche bulletin. The Avalanche Journal, 123, 28-31.

SOME USERS ARE SURPRISED ABOUT ADDITIONAL AVALANCHES ON A VARIETY OF ASPECTS NOT FLAGGED IN THE AVALANCHE PROBLEM INFORMATION. // WREN MCELROY

Evaluating Forces for Extended Column Tests and Compression Tests

Mark Sedon

INTRODUCTION

After well over two decades in the guiding and ski patrol industries, teaching courses, and running guide training, I've noticed the tap test forces of avalanche practitioners varies significantly.

We have our documented standard sizes for extended column tests (ECT) and compression tests (CT), and a clear descriptive explanation of how to perform the easy, moderate, and hard tap tests, but it occurred to me there is no known documented level of force that should be applied on the shovel through each test.

There are several reasons we should care: Do we all use the same force? Do we use the same force for left and right hands? Is our technique correct? Do we tend to tap harder in an avalanche course than we do at the top of an epic looking powder run?

During the recent Southern Hampshire Alpine Conference in Wanaka, New Zealand, I decided to gather some measurements and give some feedback on techniques. We also came up with an average newton of force applied for each test.

The two biggest variables over the two days were a highly experienced ski guide who by his own admission hadn't done a snow profile or test in roughly five years (very surprising to hear) and whose taps were so light I'm not sure they'd wake someone up from a nap on the couch, versus a very experienced avalanche instructor who beat the shovel so hard a panel beater was almost needed to straighten it out.

THE MEASURING SYSTEM

While looking for a way to measure the newtons for our tap tests, I came up with two ideas. First was a musical drum and a decibel measuring app on an iPhone. Second was a scientific testing machine from Otago University. Fortunately, we ended up with the scientific equipment.

The setup consisted of a bending beam single point load cell (manufacturer PT, model PTASP6-D 40kg) connected to a weight indicator (EMC 2060 with analog output option).

						95% confidence interval for mean			
		No.	Mean	Std. deviation	Std. error	Lower bound	Upper bound	Minimum	Maximum
Wrist	**Student**	61	24.15	11.26	1.44	21.26	27.03	6	65
	Trainer	8	26.88	9.19	3.25	19.19	34.56	20	43
	Avi 1	18	26.56	12.67	2.99	20.26	32.86	10	52
	Avi 2	46	23.74	10.85	1.60	21.69	27.37	6	65
	Total	**69**	**24.46**	**11.01**	**1.35**	**21.82**	**27.11**	**6**	**65**
Elbow	**Student**	61	62.05	23.39	3.00	56.06	68.04	15	148
	Trainer	8	59.75	13.46	4.76	48.50	71.00	37	74
	Avi 1	18	69.50	21.25	5.01	58.93	80.07	15	148
	Avi 2	46	59.20	23.43	3.45	52.24	66.15	15	148
	Total	**69**	**61.78**	**22.41**	**2.70**	**56.40**	**67.17**	**15**	**148**
Shoulder	**Student**	61	135.44	38.93	4.98	125.47	145.41	66	228
	Trainer	8	136.88	32.74	11.58	109.50	164.25	97	198
	Avi 1	18	127.00	37.25	8.78	108.48	145.52	66	182
	Avi 2	46	141.89	37.68	5.55	130.70	153.08	81	228
	Total	**69**	**135.61**	**38.05**	**4.58**	**126.47**	**144.75**	**66**	**228**

FIG. 1: THIS CHART SHOWS THE DESCRIPTIVE STATISTICS, IN NEWTONS, FOR STUDENTS VS. TRAINERS, AND AVI 1 VS. AVI 2 PRACTITIONERS. AN ANALYSIS SHOWS NO STATISTICALLY SIGNIFICANT DIFFERENCE BASED ON QUALIFICATION LEVEL OR STUDENT/TRAINER STATUS. 69 PRACTITIONERS TOOK THE TEST.

Possible Heuristic

One thing I wanted to know was: do guides or backcountry users tap softer if they really want to ski a run? And does an avalanche instructor hit harder so they can get a result to show their students? We should be tapping the shovel with no preconceived results as this might affect how hard we tap it.

The analogue signal was connected via an AD Instruments Powerlab 4/26 and displayed and recorded with LabChart 8 software on a laptop. The force was calibrated in newtons.

A thin glove was placed on the shovel to replicate the practitioner with a gloved hand. The display on the PC would show the tap force for all 10 taps in graph-form, with the readout showing the highest force. This was an unmodifiable setting that might not be ideal. An average of the 10 taps might have been better, but you could look at the graph and see if a practitioner had even taps quite easily.

THE PROCEDURE

Our source for how to conduct the tests was the 2017 NZ Guidelines and Recording Standards for Weather Snowpack and Avalanche Observations (similar to the CAA's OGRS).

- Light taps are described as: tap the shovel blade 10 times with your fingertips, moving hand from wrist.
- Moderate taps are described as: tap 10 times with your fingertips or knuckles moving forearm from the elbow.
- Hard taps are described as: hit the shovel blade, moving arm from the shoulder 10 times with open hand or closed fist.

RESULTS

We tested 69 avalanche practitioners, the majority being Stage 2 (ARM L6), the equivalent of the CAA Level 2. The results were studied by Shane Galloway, a recreation researcher and consultant.

He commented that there was no statistically significant difference between the participants based on qualification level or student/trainer status. Numerically, the trainers and Stage 2 participants were more consistent, but not

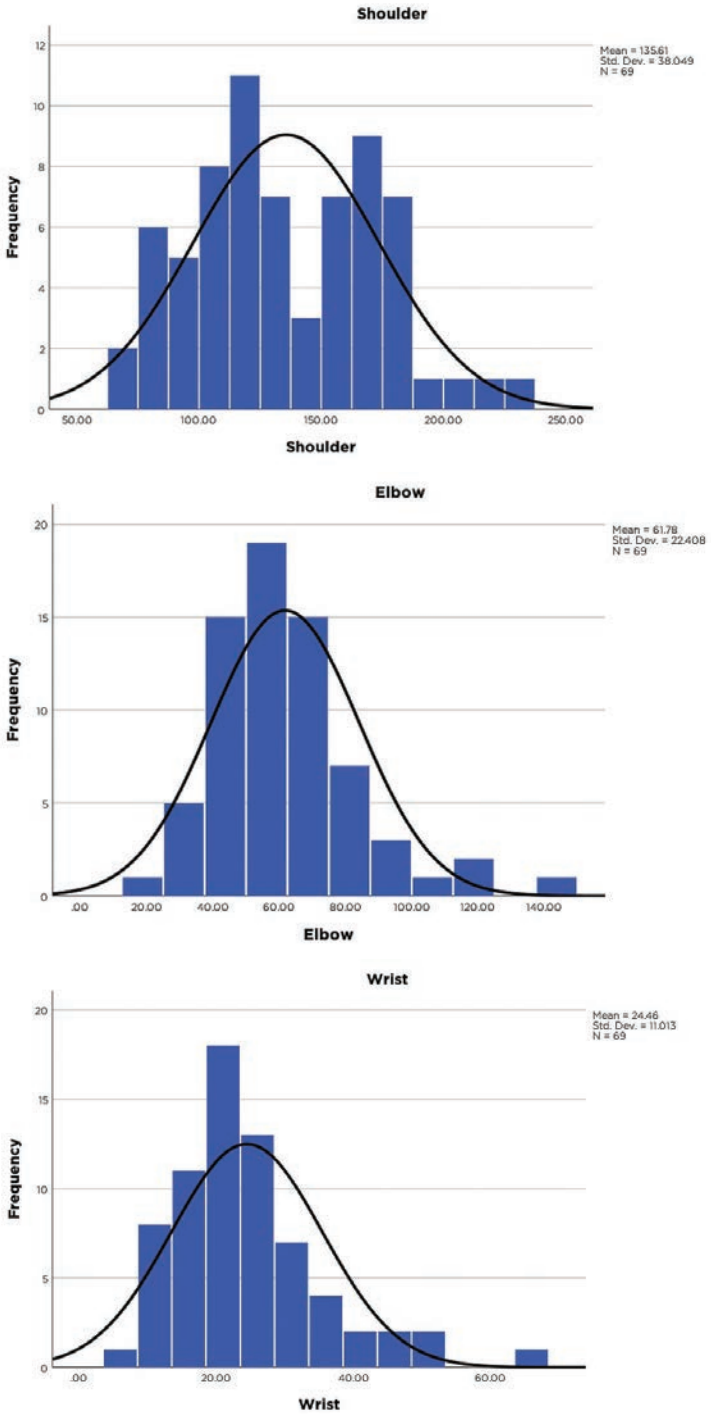

FIG. 2: THESE THREE BAR GRAPHS SHOW THE DISTRIBUTION OF WRIST, ELBOW, AND SHOULDER TAPS ACROSS ALL RESPONDENTS.

enough to make a statistical difference. However, the test did not take into account the practical difference these force measurements have on the snowpack.

Galloway suggested the test environment was less than

ideal, leading to perhaps misleading results. The coaching provided on the techniques would have made the results more consistent.

SUMMARY

Good technique generally produced similar newtons of force regardless of the person's size, anger, sensitivity, or which hand was used. It's important to train together to standardize and check everyone's technique.

When doing a light tap, about 10–15% of people let significant weight from their wrist rest on the shovel so that when they did their taps, even though their technique was good, the force applied from the taps was significantly higher. The average force for soft taps was 25 newtons.

Ten to 15 percent of people did what I called a push tap, where they tapped the shovel and held the weight there for a fraction of a second instead of tapping and releasing. I don't know which is right or wrong, but this action applied generally more pressure to the shovel.

For moderate taps, the standards say we should use fingertips or knuckles but 90% of people used their flat hand. There seemed to be no reason not to use the flat hand as the newtons applied was actually more consistent. (Maybe the standards should be updated to include a flat hand?) The average force for a moderate tap was 60 newtons.

Hard taps can be done wrong if the arm is allowed to bend. This was the case for 90% of those we witnessed. Almost everyone went wild on the hard taps and beat the shovel like a 1980's mogul skier's knees. Only the people who kept their elbow locked straight consistently applied the right force. The average force for a hard tap was 135 newtons.

STANDARDIZING TAP FORCE WITH TOOLS

I wanted to look at ways we could standardize tap test forces. Myself and Whitney Thurlow, a fellow IFMGA climbing and ski guide, had a think about what we carry with us as guides that would double as a weight to drop on the shovel. We tested a ski pole, dropping it handle first onto the shovel. Dropping it from a fist width above the shovel gave repeatedly accurate light taps of 25N and dropping it from 30cm above the shovel gave it a near-perfectly equal moderate tap force of 60N. This needs more research if and when a standard tap force is accepted.

CONCLUSION

Most participants spoke of how useful the workshop was for gauging their own tap force. Once we had a baseline, feedback was offered and I could see how it gave people a way to focus their technique. Even just having me standing there watching technique allowed people to improve. Regardless of what the newton force is, that procedure definitely narrowed the range of tap force.

Having the device at future avalanche conferences is a great way to standardize tap test forces and also discuss technique. At the end of the day, I think using the proper technique described in the guidelines does keep us within an acceptable range, but checking this technique in pairs is important to weed out bad habits.

The next step is to see what force North American and European forecasters apply to see if an international newton force can be agreed upon. It's not about waking up a sleeping colleague, or panel beating a shovel—it's all about consistency.

THANKS TO:

Shane Galloway, a recreation researcher and consultant. Grr.org.nz.
Nigel Barrett, Technical Leader & Electronics Technician, University of Otago.
Tom Harris, NZ Mountain Safety Counci

Mistakes I've Seen

THESE ARE MISTAKES I'VE SEEN WHILE OBSERVING PEOPLE CONDUCT TAP TESTS THROUGHOUT MY CAREER:

- Remember, you should NOT be looking at your hand. Watch the column of snow!
- Long, bendy saws often don't cut the back wall parallel.
- Damaging the column strength when trying to cut the top flat (hard surface).
- Hitting too hard (ECTP30's still a sign of instability).
- Wrist comes off the shovel in soft taps.
- Trying to keep elbow on shovel handle for moderate taps.
- Bending arm and brutally bashing shovel on hard taps.
- Taps gaining strength from 1–10, 11–20, and 20–30.
- Hard taps are not an excuse for releasing stress! With an ECT, we really don't want a result. Keep your hard tapping technique in check, lock that arm straight and don't use your torso.

snow globe

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SPEED DECISIONS

// GRANT GUNDERSON

Speed Decisions

In April, Greg Hill, Andrew McNab, and Adam Campbell skied from Rogers Pass to the Bugaboos in only 53 hours, setting a new speed record. This is the story of how they managed the avalanche hazard for the trip

Greg Hill

GREG HILL AND ADAM CAMPBELL HEAD UP SUGARLOAF MOUNTAIN ON THEIR SPEED TRAVERSE FROM ROGERS PASS TO THE BUGABOOS. // ANDREW MCNAB

THE DREAM OF ATTEMPTING A SPEED record on the Bugaboos to Rogers Pass traverse has been on my mind ever since Douglas Sproul, Troy Jungen, and John Walsh sent it in 80 hours back in 2005. When COVID-19 hit last year, I looked at all my dreams and prioritized the ones I really wanted to attempt. The "Bugs-to-Rogers" dream was high on the list. I made sure to train a little more to keep it realistic. I needed a good weather window and the right partners.

In mid April, the window opened and I reached out to a few fit and silly friends to put the team together. Joining up were Andrew McNab, a hardcore Revelstoke local who's well-versed in steep skiing, endurance feats, and just a great friend; and Adam Campbell, an accomplished ultra-runner, and someone who I had always talked about doing something audacious with.

We all know avalanches happen in cycles. We worry most about the high-hazard days and enjoy the low-hazard ones. Skiing the Bugaboos to Rogers Pass traverse in a fast and light manner required we go when there was zero hazard. Obviously, we all know that's never the case, but when dreaming about it, I wanted to have very few avalanche problems to think about. Imagine being 40 hours into your longest, most grueling adventure and needing to be really concerned about avalanches! Not only having to focus on moving your skis forward, but also managing micro terrain to keep yourself and team safe—all while battling fatigue. No way! This would require perfect conditions and a well-timed attack plan.

We are very fortunate there is a lot of information available to us these days. Looking back to 2005 when Sproul, Walsh and Jungen set the record, we can see so many changes. There is much more information available now that makes it a safer, more approachable mission. I could write a long list of all the new technologies that make it better, like small portable GPS communicators, and lighter and better ropes, but the biggest change, in my opinion, is the availability of snow information. Working through MIN reports, Avalanche Canada forecasts, and many other resources, we could get a real detailed look at the snowpack we could expect to encounter. When you realize every elevation band will be encountered several times and you'll cross two different mountain ranges, each with their own snowpack, it becomes very complex to decide the timing of everything.

A big decision was deciding which direction to go. Typically people go from the Bugaboos to the Pass. This way, skiers can time their ascents up the south aspects and then enjoy riding the softer north facing snow. It makes a lot of sense—you set your team up in the ideal position and then go up those hazardous slopes when they are the least dangerous. For a speed traverse the timing is crucial for every crux, but there is a distinct advantage for going in the opposite direction. It is much safer and easier to climb a north-facing slope in the afternoon, whereas climbing any south or west facing aspect would be scary at those times.

"Timing is everything!"—I am not sure who said that, but it definitely applied here! We had to look at the entire traverse, pick out the critical slopes, and then decide when they would be safe to climb or ski. We wanted to make sure we reached them in the morning, before they had a chance to warm up. Next, we looked at all the slopes in between those crucial cruxes.

It seemed counterintuitive to me when it was suggested it would be best to go from north to south, but the deeper I looked at it, the more clear it became. We looked at the high-alpine cruxes—Grand, Sugarloaf, Syphax—and realized all of them

had much longer windows of safety if we were approaching from the north. Climax Col faces west and we would have to time it precisely, but the rest were simpler to deal with from the north. And we wanted simplicity to make our decisions easier.

McNab, Campbell, and I left the parking lot in Roger Pass and skinned south on April 19 at 4:20 a.m. The flow was easy and psyche was high, but immediately I realized the precipitation that had fallen a few days before had fallen as rain really high. The snow was almost ice to the top of the Illecillewaet Glacier.

Our first real descent down to the Deville was also very hard, with little warmth in it yet. Teeth chattering, I wondered if we didn't have the conditions we hoped for. In our research, we found a snow couloir directly beside the rappels; the snow was well settled from the warm precip, which made for perfect boot packing. Busting onto the Deville, we finally crested past the rain line and found some softer snow to tour on. This led us across the flats and up the north flank of Grand Mountain. We skinned through 10cm of beautiful settled snow to a high col. Working our way into the couloir on the south, we found a deep, wind-loaded pocket with up to 45cm of new snow sitting on a harder crust. Not fully slabbed up, I was able to push through and get into less of a deep pocket. It all worked out and we glided across to Sugarloaf.

A steep, slightly crusty descent off Sugarloaf led us down the Donkin glacier. Mostly settled snow and some really fun spring carving brought us down the 1,750m descent to the Beaver Valley. We ate some food and waited a little bit for the solar heated slopes above us to cool. At around 6 p.m., we started up and found the slope was supportive and perfect settled corn. It was mostly perfect skinning, with the exception of a couple of isothermal collapses that kept us honest.

For five hours we wandered in sub-alpine terrain, with supportive snow that seemed a bit fresher from the recent precipitation. Some images from the Bugaboo Lodge showed it had snowed more there than in the Selkirks. Reaching the Mark Kingsbury Hut near midnight, we huddled under a tarp for a few cold hours before heading off again early in the morning.

On day two, we realized there truly was more new snow on the north faces. Our confidence in the snowpack was where we wanted it to be and we approached Syphax with confidence. We bootpacked up a 40-45 degree snow slope and knew we had the conditions needed to cross under the summit. Facing west, this exposed pocket sat precariously above some massive cliffs, but at 11 a.m. it was cold and the snowpack was tight so a quick bootpack led us across the shortcut and into more alpine terrain. At this point the day was getting warmer and we had to push the terrain a little more. Luckily, the slopes were small and still facing north or northeast, so we mostly avoided any exposure to warming and sagging cornices. We zipped across Snowman Lake into the next valley. The daytime heating was warming the snow pack, but the terrain was manageable and only the top 20cm was moist.

We approached our biggest hurdle just past the heat of the day: Climax Col, a steep, 150-vertical-metre, west-facing slope. Looking up at it, we were concerned. It had shallow rocks and possibly some loaded pockets. No new wet sloughs had slid down its flanks, so we approached. Somehow, it was still cold. Kick-turning our way up, I expected warm, wet snow, yet it remained stiff and almost crunchy. We navigated around a couple of deeper pockets and stayed on the side-slip tracks from the groups we passed. Cresting the ridge, we breathed a sigh of relief. Our biggest safety concern for the day was done. A mega side-slip around the head of the valley was next, then we stopped to eat and waited for the slopes above to cool.

We chased the setting sun up the next slope and reached the soul crushing Conrad Icefield traverse. Night settled in so we stopped at the Malloy Hut to rest. We awoke to another beautiful day and headed towards the Bugaboos. A bulletproof descent was followed by a fantastic tour up to the Bugaboo-Snowpatch Col. Exhilarated by our success, we were rewarded with steep powder turns down the other side. We skied down to the valley, avoiding the warming cliffs and gratefully finished this traverse at the Bugaboo Lodge—53 hours after we started.

When I think back onto this trip, it's the perfect conditions that blow my mind. In all that terrain we only encountered a little bit of wind-loaded snow, a tiny bit of isothermal snow, and some bulletproof conditions, but mostly the snow was perfect. Like I said, it is all about timing, but these days it is also about all the research and information available. Using all the tools that are now in our toolbox can guarantee better successes in the mountains.

Drone Control Has Arrived
Sentinel 6000
Single Shot, Muzzle Loaded, Gravity Activated

Dear CAA Members,

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

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

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

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

The system equipment consists of:

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

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

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

Maple Leaf Powder Company

David Sly, President

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250.661.3450

Maple Leaf Powder Company

Sentinel 6000 drone and payload box

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