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Publications Mail Agreement No. 40830518 Indexed in the Canadian Periodical Index ISSN 1929-1043

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Contributors

JOHN G. WOODS

John's association with Rogers Pass and the Schleiss family started in 1975 when he moved to Revelstoke as the Chief Park Naturalist for Glacier and Mount Revelstoke national parks. The need to safely travel in avalanche country during all seasons came with his job. Encouraged by Fred Schleiss, John soon-after attended a week-long avalanche safety course presented by Peter Schaerer in Rogers Pass and became fascinated by snow science.

Working together with Fred, and other avalanche professionals, John helped to weave the present-day avalanche story into the park interpretation programme with projects such as the National Film Board movie "Snow War" (1978), the Rogers Pass Discovery Centre (1984), and a book "Snow War: An Illustrated History of Rogers Pass, Glacier National Park, BC" (2010).

More recently, John was the lead researcher for the "Land of Thundering Snow" online exhibit presenting the history of avalanche safety and science across Canada (2015, Revelstoke Museum & Archives with the Virtual Museum of Canada; landofthunderingsnow.ca.

10 SAFE PASSAGE THROUGH ROGERS PASS IN THE WINTER: A SCHLEISS FAMILY LEGACY

MIKE CONLAN

Mike Conlan graduated from the Applied Snow and Avalanche Research group at the University of Calgary (ASARC) in 2015. Since then, he has been working in the avalanche industry as a professional engineer with BGC Engineering, instructor with the CAA ITP, and public avalanche forecaster with Avalanche Canada. Mike is enjoying his recent move from sunny Calgary to cloudy Revelstoke.

18 A DECISION SUPPORT TOOL FOR PERSISTENT DEEP SLAB AVALANCHES

KEVIN HAMMONDS

Kevin Hammonds has moved from park ranger and ski patroller to Assistant Professor of Civil Engineering at Montana State University. His research into the material properties of ice and snow as it exists in clouds, snowpacks, and ice sheets is a means to better understand the very significant role that ice and snow plays in our natural world. To quote Kurt Vonnegut, "Science is magic that works."

21 LEAVE YOUR THERMOMETER HOME... BUT DON'T FORGET YOUR LOUPE!

JORDY HENDRIKX

Jordy Hendrikx is the director of the Snow and Avalanche Lab and Associate Professor at Montana State University. He has worked in number of different snow avalanche climates, including Zealand, North America, Antarctica and the Arctic. He has published work on avalanche risk, avalanche forecasting, spatial variability and climate change. Recent work has shifted towards decision making and terrain use in avalanche terrain.

28 CROWD-SOURCED: TRACKS AS AN EXPRESSION OF RISK

Parks Canada - Banff - Bourgeau Gazex Avalanche Path Control

Images: Ian Jackson

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Layer **Cake**

Jill Macdonald
Managing Editor

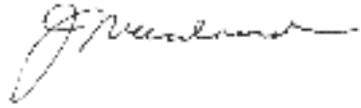
LAYER CAKE – it's an obvious metaphor for the snowpack of a sporty season. The layers of sun crusts, surface hoar, and wind slabs that snow scientists may love, are the same ones that guides and safety specialists may loathe. People tend to fall decisively on either side of the fence. Chocolate or vanilla. Icing or no icing.

From the periphery of the avalanche industry, snow science is fascinating. It's the hard data in the recipe for decision making and risk management: two parts beta, one part experience, a dash of intuition and a sprinkle of luck. In winter's most exquisite chemistry experiment, layers upon layers of intricate crystals are in a constant state of change. It's no wonder that efforts to quantify and understand the transformation processes becomes a life's work.

We can't discuss snow science without paying tribute to people. The Schleiss family have made significant contributions to the advancement of snow science and the history of Rogers Pass. It's a romantic story and one that continues. Growing up in Rogers Pass, watching the snowpack come and go, each season forming an intimate relationship, the same but different than the one before. The Schleiss art of living has become a foundation for future generations of academics and practitioners.

The impetus behind a snow science issue was to provide points of discussion and reflection mid-season. Science and art are two sides of the same coin. The natural world as we encounter it, translated into concepts and language, the tools we need to navigate. Study reveals more knowledge and sometimes resurfaces past knowledge, in a new light. You can have your cake and eat it too.

Dig in. Hopefully there is something for everyone.



Jill Macdonald

Letters to the Editor **Correction**

Article title: North Route Café
Volume: 116//F 2017
Bruce Jamieson was missed as a principal author of the article.

Walter Bruns
CAA President

President's Message

SNOW...SCIENCE...hmmm. That must mean the science of snow. How hard can that be? It's frozen water; falls from the sky; accumulates on the ground; fun to slide down when inclined. Nice. But it also slides of its own accord, or when provoked, and that can kill people. Not nice. Since we live in the snow, and as we work or play in the snow, we had better figure this out. It's a complex study, so much so that there is an international scientific workshop for researchers.

Applying scientific method to the study of snow is straightforward. The physics (classical mechanics, thermodynamics) is entirely understood. The math (eg.- boundary-layer theory for non-linear partial differential equations) is there for us and we have the computers to crunch it.

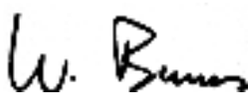
On the other hand, the tools of the trade are pretty basic (shovel, ruler, magnifying glass, thermometer, etc). The experimental techniques are quite rudimentary (dig a hole, poke the wall, slice/weigh/push/pull/beat on samples, etc). There is this stark, yet delightful contrast between the scientific sophistication of some elements of the method, and the complete crudeness of the approach in others.
The 'grand unified theory of the snow', if you will, is now well understood. What is much harder to understand is how snow presents a danger to people.

Here comes the most delicious aspect of the entire undertaking: While the scientific observer stands apart from the experiment (indeed, there is an effort to avoid an 'experimenter effect'), the snow scientist who wishes to relate snow and safety must step into the experiment! The degree of safety (or of its inverse – danger) is a function of risk management, which necessarily requires the subject to participate in some fashion.

The understanding of snow and safety has evolved dramatically in Canada, due in part to scientific interest, but more so out of operational necessity. From the earliest railway workers, to the miners, road builders and growing number of recreationists today, we have had to figure it out.

And figure it out we did, with substantial success. From the good old, seat-of-the-pants days of the wild west, through the era of classical snow science, to the realm of human motivation and behaviour, the development of our understanding has been profound. And it continues.

This issue presents many interesting articles describing and furthering that evolution. Please read on, out of interest, and to enhance your own understanding.
With best wishes for a safe and snowy season,



Walter Bruns, CAA President

Eiri Smith
Comptroller

New Staff

EIRI SMITH comes to the CAA from Revelstoke Mountain Resort where she worked for 6 years performing various reconciliation and accounting functions. Prior to living here, Eire spent 12 years in financial administration, dealing with regulated investment funds in the UK. The lifestyle here is far more to her liking and she looks forward to playing a vital role on the financial side of the CAA. We welcome Eire.

Executive Director's Report

REACHING OUT AND MOVING AHEAD

Joe Obad
CAA Executive Director

AS THIS EDITION of the journal goes to press we have slipped into 2018. For several years in our plans with the Board, staff and members, 2018 seemed so far away. But sure enough, the date crept up on us and here we are, with a mix of progress, surprises and concerns.

In 2016, ITP manager Emily Grady and I applied for funding to the National Search Rescue Secretariat (NSS) to revise and update the Avalanche Operations Level 1 and Level 2 courses. With the funding secured, Emily assembled a strong project team to rework the Level 1 course to align with the competency profiles developed in 2014. If things continue to go well, the revised Level 1 course will be implemented in fall 2019. Work on the Level 2 program begins this spring, with the anticipated delivery in Fall 2020.

Upgrading the ITP program is just one of the required adjustments as we work towards a competency-based approach to training and membership. The ITP program will validate many competencies as aspirants seek to become Active or Professional members, but not all competencies are suited to assessment within ITP. For competencies better suited to assessment in the workplace, a concurrent effort is underway to develop a workplace portfolio. Jan Johnson and Tony Sittlinger are putting together tools for aspirants to track their development in the workplace. Together with realigned ITP training, these and other pieces will form part of a revised application process.

November 2013 marked the kick-off for InfoEx 3.0. There were growing pains as subscribers adapted to the new software and we focussed on responding to their needs. While there was discussion around offering the program internationally, our view was to expand only if it made sense and supported the needs of Canadian subscribers. In 2016 we began licensing the software to Sweden, bringing in revenue to avoid high subscriber rates.

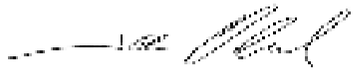
This fall the board supported a plan to create an international version of InfoEx (with a completely separate database) that we could offer in the US and other countries. Through an expanded subscriber base, we seek to add revenue to increase quality delivery at home while avoiding cost increases. With increased income, we can also address much sought after features like mobile-friendly interfaces, automatic weather station and more.

As we close the financial year, I'm pleased to say we have met the board's target of 5 - 10% surplus for Association, ITP and InfoEx. Our major projects supported by NSS have all been run soundly thanks to Emily's leadership and fabulous administrative support from Susan Hairsine.

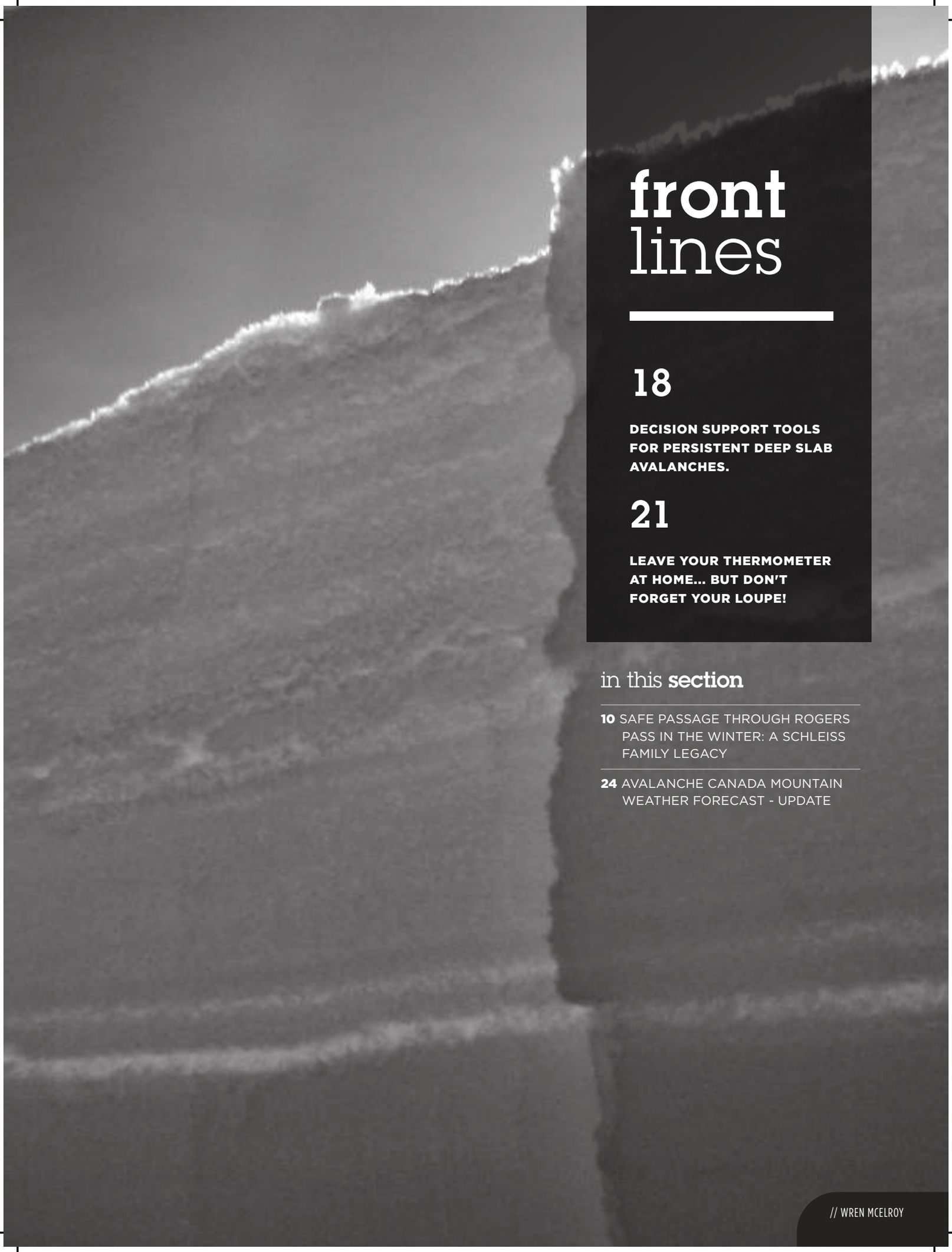
Looking into the 2019 budget, there are some concerns we need to address. Our greatest concern is the budget for Association/Membership. With the loss of several retail and wholesale sales areas, our revenues have shrunk as demands on Association (more CPD events, advocacy related to government etc.) have increased. We have been working hard to offset these losses with increased revenue from sponsors and other sources. As we head towards the AGM in May, we will provide the Board with several options, including changes to member dues. One option that has been discussed is a model of smaller, incremental membership dues increases to avoid a shock related to catching up when dues are adjusted every 5 to 7 years. In any case, we need to present the board and membership a long-term sustainability plan for the Association side of our ledger.

2018 offers a bittersweet milestone. After 14 years as comptroller Janis Borden is stepping back slowly as she trains incoming comptroller Eiri Smith. We welcome Eiri and are excited to have her join us. Yet we are sad to lose Janis as she steps back to enjoy more time with family and friends. Janis has ably served several executive directors, many staff presidents and board directors. She has chased down the invoices and remedied more financial challenges than I can begin to guess at; all with an eye to serving members. Janis runs a tight ship, evidenced by squeaky clean reviews in our first two years under full audit. On behalf of all of members and staff, thank you Janis for your many years of excellent service!

As ever, if you have any questions about this editorial, programs or projects – please get in touch. Until then, I wish you all good snow and continued safe operations this season!



Joe Obad, CAA Executive Director



front lines

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DECISION SUPPORT TOOLS FOR PERSISTENT DEEP SLAB AVALANCHES.

21

LEAVE YOUR THERMOMETER AT HOME... BUT DON'T FORGET YOUR LOUPE!

in this **section**

// WREN MCELROY

Safe Passage Through Rogers Pass In Winter: **A Schleiss Family Legacy**

John G. Woods

THE HIGHWAY CORRIDOR THROUGH THE ROGERS PASS IS DIRECTLY AFFECTED BY NUMEROUS AVALANCHE PATHS // PARKS CANADA SRAWS

WHEN VEIT (FRED) AND WALTER SCHLEISS were growing up in Gurk, Austria, skiing and mountaineering were a way of life. Everyone skied, everyone went up the hills on climbing skins, and everyone accepted that to enjoy winter, you had to know about avalanches. As part of a mountaineering family in the 1930s and early 1940s, the brothers skied good runs just outside of town and the Alps were a short distance away. How could they have known that by the time they were in their twenties, they would be enjoying the same lifestyle more than 8,000km away, in the tiny alpine community of Rogers Pass, in the heart of Glacier National Park, Canada.

Emigrating to Canada in 1955 at the age of 26, it didn't take long for Fred's climbing boots and backcountry skis to find adventure—in the Canadian bush, on the mountain slopes, and by 1957, as alpine specialist for Jasper National Park. With formal training in engineering and construction, and experience in surveying for avalanche terrain and locating defence structures in post-war Austria, it isn't surprising that Fred soon attracted the attention of the massive Trans-Canada Highway construction project underway through Rogers Pass in Glacier National Park.

Fred's invitation to join the embryonic Rogers Pass avalanche team came late in 1959, two winters before the highway was opened to public travel. At the time, Noel Gardner headed the group and Peter Schaerer had been involved in a variety of key avalanche design and operational roles in the pass for several years. It must have seemed like a dream come true—Fred's new job placed him as second in charge of the avalanche team in winter, and alpine specialist in summer.

As lucky timing would have it, the avalanche team also was looking for another recruit, this time to fill a junior avalanche observer position. Walter had followed his brother's trail to Canada in 1956 and was about to start a ski patrolling position in Jasper when the call came: was he interested in the job? Within a few months, the Schleiss brothers were both embedded in a rapidly crystalizing Rogers Pass avalanche team that within a few years would become world renowned as the "Snow Research and Avalanche Warning Section"—often referred to by the acronym "SRAWS".

1957 FRED (L) AND WALTER SCHLEISS (R) COLUMBIA ICEFIELDS JASPER NATONAL PARK // SCHLEISS FAMILY

APRIL 1968, THE ROGERS PASS 'COUSINS' BIKE GANG,
(L-R) DIANA, MARY, JOHANN AND GLENDA // SCHLEISS FAMILY

APRIL 1978, SCHLEISS FAMILY MT FIDELITY (L-R) WALTER,
DIANA, FRED, MARY, JOHANN, EDIE // SCHLEISS FAMILY

WALTER PREPARING FOR A RESCUE // SCHLEISS FAMILY

Unlike most roads of the day, the government built the Rogers Pass segment of the Trans-Canada Highway through Rogers Pass (Golden to Revelstoke) with the avalanche problem clearly in mind (Schleiss V.G., 1989; Woods 2010). The Canadian Pacific Railway's history through the route underscored the magnitude of the issue and the highway engineers avoided, where possible, the worst of the avalanche terrain. Most importantly, the highway construction included a network of avalanche static defence structures (snowsheds, mounds, diversion dikes), along with the development of an operational program of mobile avalanche control using explosives. With the decision to use the 105 mm Howitzer as the delivery system of choice, a joint operation of the Canadian Armed Forces and the National Park SRAWS unit went into motion in 1961, one year before the highway was opened to the public.

During the years of Fred and Walter's work on the SRAWS team, use of the gun was continually refined to turn it from its original military intent as a field artillery piece, to a precision gun able to repeatedly deliver its 2.4 kg payload with great accuracy to targets as much as 8 km away, whatever the time, whatever the weather. In an oral interview at the Revelstoke Museum and Archives in 2015, Walter was quick to praise the ability of these gun crews, some recent veterans from the Korean War, to adapt to their temporary assignments as "snow punchers" in Rogers Pass (Schleiss, W 2015).

In the early days of SRAWS, accommodations in Rogers Pass, of a sort, came with the job, so the Schleiss brothers were both at home and at work, most of the time. Repurposed construction buildings, trailers, and make-shift research stations in the pass provided living quarters. Satellite research observatories on Fidelity Mountain, Mount Abbott and at the summit of Balu Pass served as high elevation outposts much closer to the trigger zones of the more than 140 avalanche paths that affect the highway and railway.

The first Fidelity station was particularly rustic—essentially a plywood frame partially lined by a tent and slowly "renovated" to include a few bunks, kitchen supplies and a transistor radio. Magnanimously named "Casa Grass Observatory" after part-time carpenter Arnold Grass, another winter season SRAWS team member at the time, the modern day Mount Fidelity Observatory continues to be a strategic location for avalanche observations critical to forecasting the hazard along the Rogers Pass route within Glacier National Park.

When Walter married in February 1961, he was stationed on Fidelity for the winter. This meant that his new bride, Gerry, lived with him in Casa Grass for the first three

months of their marriage. Since the only way up the mountain at the time was on skis, and Gerry had never skied before, that climb up the mountain was a marathon lasting more than six hours. At the top, Gerry was greeted to what must have looked like the entrance to a grizzly bear den buried by metres of snow. As the saying goes, "all's well that ends well".

Two children (Diana and Glenda), 4 grand children and a great-grand child later, Walter and Gerry celebrate their 57th year of marriage in 2018.

Fred was joined by his new bride, Edie, in 1962. By then, the first Mount Fidelity Station was in place and the young married couple spent the winter of 1962-63 there in relative luxury (compared to Casa Grass!). Over the next four years, they became the proud parents of Mary and Johann. By 1966, there were four Schleiss cousins, and several other staff children, growing up in the tiny park headquarters community located across the street from the present day Rogers Pass Discovery Centre. The children enjoyed skiing and riding their tricycles on the doorstep of a mountain wilderness.

Avalanche paths backdropped their playgrounds in all directions. During control operations the children would have regularly heard the Howitzer fire, the resounding thuds as it hit its target and occasionally, the thunderous roar of the resulting snowslides. Years later, Johann fondly remembered his Dad taking him at a very early age to see avalanches in action and the "snow work" done by the SRAWS team (Schleiss, J. 2015).

By the winter of 1965-66, the Trans-Canada Highway was entering its fourth winter of full operations and there was a fundamental shift in responsibilities for avalanche operations. With the departure of Noel Gardner, Fred was appointed the senior avalanche forecaster and Walter graduated from observer to second forecaster. Together, they adopted a work sharing system that saw at least one of them on duty every day and night throughout the avalanche season. As SRAWS manager, Fred worked Monday to Friday (to allow him to meet with other park managers and the superintendent), while Walter worked the weekends. In a brotherly manner, they alternated having Christmas or New Years off from year to year.

For the next 26 years, the Schleiss brothers worked to establish and refine the observational and operational standards in Rogers Pass that would influence the evolution of the avalanche profession in Canada and beyond. At a conference on "*Ice Engineering and Avalanche Forecasting and Control*" held at the University of Calgary in 1969, they presented an early summary of their techniques (Schleiss and Schleiss 1970), including their use of the shear frame test to assess snowpack stability. Recognition of the role Rogers Pass was playing at the time came in the form of visits by avalanche professionals from around the world.

In 2007, the Canadian Avalanche Association awarded a 25th anniversary lifetime achievement award to Fred in recognition of his role in developing professional standards. It is these standards, that continue to establish confidence in the observational data taken by observer field teams who pass information to the operational command forecasters. With a multitude of slide paths and hundreds of avalanche control targets, two weather patterns (moist Pacific, cold continental) meeting at the summit of the pass, and an every increasing traffic volume, timely, accurate, legible, repeatable snow observations—the snow work that Johann had seen as a boy—became a trademark of the SRAWS operation.

By 1970, the Schleiss families moved their homes from the pass to the alpine town of Revelstoke. Fred and Walter continued their Rogers Pass forecaster positions and the Schleiss cousins went to school in town. Mountains, avalanche paths and ski slopes continued to be part of the family's neighbourhood scenery and skiing was a favourite activity. Not surprisingly, Johann became a keen skier and mountaineer and decided to make avalanche safety his life's work. He joined the modern day Rogers Pass avalanche team in 1989 as an assistant observer. Working up the ranks, Johann became an avalanche forecaster in 2017 and, like his father and uncle before him, is proud to be part of continually evolving team of avalanche professionals who have given millions of motorists safe passage through his home mountains in winter.

Reflecting on his first time as the person who "called a shoot" with artillery in Rogers Pass, Johann describes the experience as underlining the importance of every facet of the program. The indispensable role that the field teams play as the eyes and ears of the operation. Their observations and measurements must be clear, precise and trusted. The reality that during a shoot, traffic will be constantly building in the limited safe ponding areas between the slide paths. The need to be sure that each round fired has done its job of stabilizing the slope without bringing snow onto the highway. The vital role the army plays in firing the Howitzer as a precision instrument. The need to closely coordinate closures with his provincial avalanche colleagues in charge of the highway outside of the Park. The crucial role of highway maintenance crews in working to keep the road surface ready for the thousands of vehicles that will use it every day during the avalanche season. The confidence needed to reopen the road knowing that a few minutes after he declared the highway ready for traffic, there would be two continuous lines of cars and trucks passing beneath the slopes that he had just stabilized.

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EDITOR'S NOTE:

Fred and Walter Schleiss are both honorary members of the Canadian Avalanche Association. Fred served as the Association's Second President (1984-86).

1961 SOUTH PEAK FIDELITY MOUNTAIN (L-R) ARNOLD GRASS, NOEL GARDNER, FRED SCHLEISS AND WALTER SCHLEISS // SCHLEISS FAMILY

1978 CIRCA FRED SCHLEISS AT BALU PASS SUMMIT // PARKS CANADA

LIKE HIS FATHER AND UNCLE BEFORE HIM, JOHANN SCHLEISS IS PROUD TO BE PART OF CONTINUALLY EVOLVING TEAM OF AVALANCHE PROFESSIONALS IN ROGERS PASS // PARKS CANADA

A Decision Support Tool for Persistent Deep Slab Avalanches

Michael Conlan
2015 Graduate of Applied Snow and Avalanche Research group at the University of Calgary

DURING MY GRADUATE STUDIES with the Applied Snow and Avalanche Research (ASARC) program at the University of Calgary, my primary focus was geared towards studying persistent deep slab avalanches. To understand what we did, it is first important to indicate our research definition of these events. In the broadest sense, we were analyzing hard-to-forecast avalanches that released on persistent weak layers buried relatively deep within the snowpack. With the most recent avalanche problem type definitions defined by Statham et al. (2018), these avalanches would generally fall within either a persistent slab avalanche or deep persistent slab avalanche problem. Approximately 40% of the releases would fall under persistent slab avalanche because they released within the middle portion of the snowpack and on surface hoar. The other 60% would be classified as deep persistent slab avalanches, as they released in the bottom portion of the snowpack and on faceted grains or depth hoar. Nonetheless, all the releases were deemed to be hard-to-forecast, as they all released outside of prominent avalanche cycles.

One of the primary goals of this research was to prepare a decision support tool for persistent deep slab avalanches to aid avalanche professionals in their decision-making process. To do this, over 30 hard-to-forecast avalanches were visited during my time at the university (totaling over 60 during the ASARC program), generally within 1 to 3 days post-release. For each avalanche, we performed a variety of analyses, such as fracture line profiles, deep tap tests and propagation saw tests, and an analysis of the weather leading up to each event (above photo). These results were used to prepare the decision support tool, along with complimentary studies, such as an expert opinion survey and an analysis of deep slab avalanches within the InfoEx.

The decision support tool is shown in Figure 2 and includes three sections: snowpack information, weather information, and previous avalanche

A PROFILE CONDUCTED ADJACENT TO A PERSISTENT DEEP SLAB AVALANCHE TO GAIN INSIGHT INTO THE WEAK LAYER, OVERLYING SLAB, AND TO PERFORM SNOWPACK TESTS ON THE FAILED WEAK LAYER. // MICHAEL CONLAN

observations. To use the tool, the user answers 11 yes or no questions, which shouldn't take longer than a minute or two to complete. The tool uses a threshold sum approach, where all the yes responses are added up (called the tool sum) and subsequently compared to a threshold value. For example, if you respond yes to any of the questions on the tool, it will add a value associated with that question to the tool sum. If the tool sum is greater than the threshold amount, then the tool will indicate that persistent deep slab avalanches are likely.

Let's say we have a deeply buried weak layer within our snowpack. If we have enough information about the layer, such as grain size, hand hardness and fracture character, along with information about the weather and nearby avalanche activity, then we can use the tool. General characteristics that increase the likelihood of persistent deep slab avalanches include large persistent weak layer grains, sudden fracture characters, high propagation potential test results, substantial new load or snowpack warming, and signs of previous avalanche activity. The tool was designed for predicting naturally triggered avalanches, but also provides insight into artificially triggered avalanches.

The tool includes both a daily tab (Fig.1) and a seasonal tab (Fig. 2). The daily tab can be used for any particular day during the winter. The seasonal tab is essentially a database of the daily results. This option provides the ability to observe changes to the tool results over multiple days or for the entire season. Further, the user can enter actual persistent deep slab avalanche observations within their working area and compare actual observations to the tool predictions. Comparing actual observations to the tool predictions may allow for regional-based calibration of the tool for use in future years.

FIG. 1: DECISION SUPPORT TOOL. THE USER ANSWERS THE YES/NO QUESTIONS AND THE TOOL WILL INDICATE IF PERSISTENT DEEP SLAB AVALANCHES ARE LIKELY, POSSIBLE, OR UNLIKELY.

Persistent deep slab avalanche forecasting tool

ASARC

	Response (yes/no)
Snowpack conditions. For the preceding week within start zone locations. buried at least 80 cm in snowpack, in a regional setting.	
I have observed:	
• a persistent weak layer of faceted grains (> 2 mm), surface hoar (> 4mm), or depth hoar (> 4 mm).	yes
• a persistent weak layer that is at least 1 step softer than the underlying layer.	yes
• sudden fracture character OR high propegation potential on a persistent weak layer from snowpack tests.	yes
• a melt-freeze crust that is at least P in hand hardness directly under a persistent weak layer.	no
Weather conditions. For start zone locations.	
I expect/have observed:	
• an additional load of at least 34/10/15* cm of snow over a 24-hour period, 58/38/19 cm of snow over a 3-day period, OR 79/68/30 cm of snow over a 7-day period	yes
• at least 13 mm of rain in a 24-hour period	no
• a maximum air temperature increase of at least 8 °C in a 24-hour period OR 13 °C in a 3-day period AND the maximum air temperature will reach at least -2 °C.	no
• an air temperature drop of at least 14 °C in a 12-hour period.	no
• no overnight freeze for the first time since a freeze	no
• direct shortwave radiation hit start zones for the first time after a snow storm. OR SWarm estimated warming of at least 5 °C 10 cm into the snowpack.	no
Avalanche conditions. Regional observations for start zone locations.	
I have observed:	
• deep slab avalanches in the past 4 days at similar elevations to the area being forecasted.	yes
Naturally triggered persistent deep slab avalanches are likely	11
Human triggered persistent deep slab avalanches are likely	

Notes:
* xx/xx cm of snow are for expert opinion/weather station at or below treeline/GEM15.
The tool indicates the likelihood of observing persistent deep slab avalanches for the day it is used. It does not indicate if, when, or where they will occur.
The tool must be applied to certain terrain features of concern when applying the tool. Spatial variability must also be assessed.
Copy the yes/no responses to the 'season' tab for seasonal progression and potential future calibration.

Like with any tool, there are some limitations. Although we tried to access avalanches within different snow climates, the majority (63%) of the avalanches visited were in a transitional snow climate within the Columbia Mountains, so the results are more applicable to this region. Locations in the Coast Mountains, Rocky Mountains, northern regions, or with unusual micro-climates in the Columbia Mountains may require regional-based calibration of the threshold values that change the likelihood. The tool also does not account for terrain differences (e.g. aspect or elevation) so the user should apply the tool for particular terrain features of interest. Given that this tool is designed for probably the most difficult avalanche problem type to forecast, conservative measures are built into the tool. As a result, the tool may produce many false alarms; however, given the consequence of these generally large and destructive avalanches, we feel that this is a reasonable approach.

The tool is available as a spreadsheet at the following link: https://schulich.ucalgary.ca/asarc/node/338 (or search for "Deep Slab Decision Support" to get to the same page).

More information about the research and the development of the tool is presented in our latest open-access article (Conlan and Jamieson, 2017).

We hope that this tool is an asset to avalanche professionals' decision-making process. I value any further discussion about this tool, such as its usefulness or questions about calibrating it for particular regions – mike.conlan@ucalgary.ca

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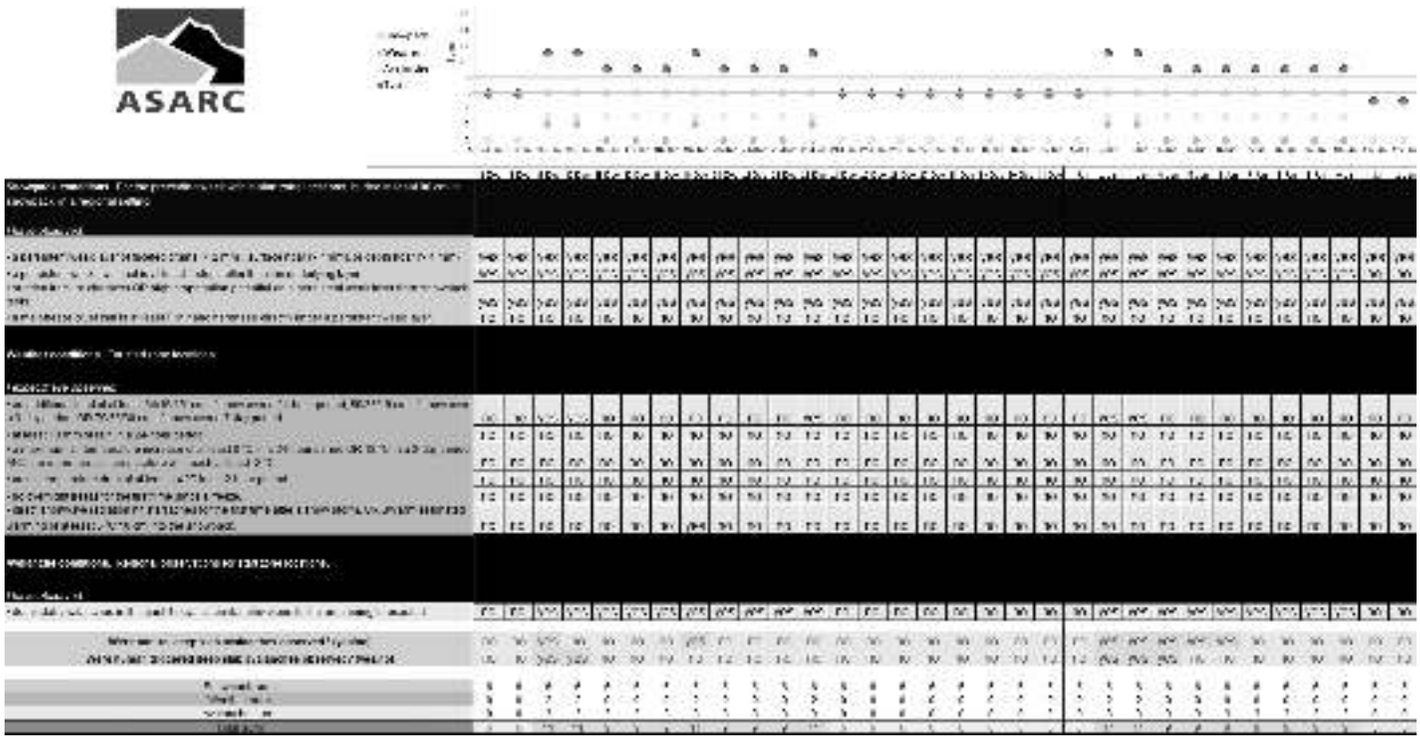
FIG. 2: DECISION SUPPORT TOOL ANNUAL TAB. THE USER ANSWERS THE SAME QUESTIONS AS IN FIGURE 2 AND CAN TRACK CHANGES AS THE SEASON PROGRESSES. BY FILLING OUT WHETHER AVALANCHES WERE ACTUALLY OBSERVED, THE TOOL COULD BE CALIBRATED FOR A PARTICULAR REGION IN FUTURE YEARS.



Leave Your Thermometer at Home… **But Don't Forget Your Loupe!**

Reprinted from *The Avalanche Review* 35.1

Kevin Hammonds
Ph.D. Candidate at the Thayer School of Engineering, Dartmouth College, Manager of the Dartmouth Ice Research Laboratory

Ethan Greene
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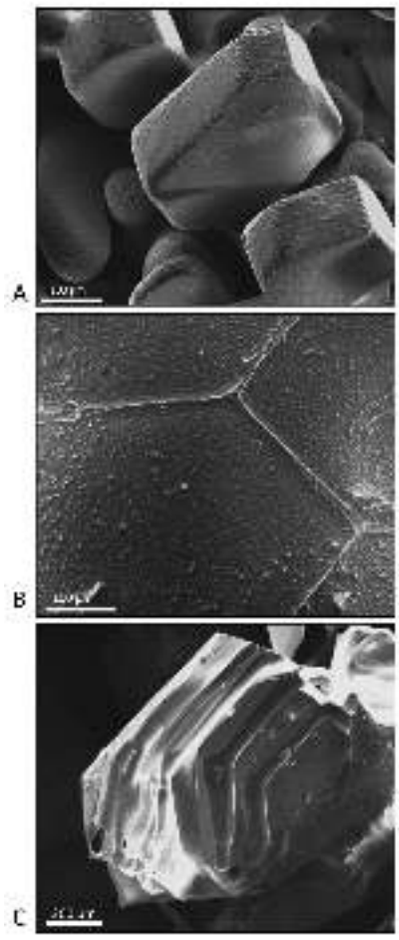
AS IT TURNS OUT, spending many an extra cold and blustery minute trying to get those last few temperature readings from your snowpit wall for a textbook perfect "every-ten-centimetre" tem- perature profile may not be all that helpful, and if anything can even be misleading. Based on recent laboratory research conducted at the Dartmouth Ice Research Laboratory (see Hammonds et al. 2015) and succeeding other earlier but similar work (see Greene 2007), it would appear that perhaps the most critical of temperature gradients are those that cannot be directly measured…at least not with your standard field-based instrumentation.

In Hammonds et al. (2015), a study funded by the AAA, the authors created an artificial snowpack consisting of an ice lens sandwiched between two layers of old natural snow grains. They placed the sample under a controlled temperature gradient for 48-hours and observed the microstructural evolution of the ice-snow interface via micro-CT imaging while recording the temperature gradients within the sample with a custom built micro-thermocouple array. From the micro-CT imaging, new ice crystal growth occurred from the bottom surface of the ice lens while the top remained smooth.This observation was in line with the previous work of Greene (2007). In addition to Greene (2007), however, were the temperature gradients that were recorded near the ice-snow interface on a sub-millimeter scale.At these small scales, local temperature gradients were observed to be as much as 40 times that of the bulk temperature gradient that had been imposed over the sample.These results are thought to be of significance to avalanche forecasters for two primary reasons:

1. Slab avalanche activity has long been observed to occur near icy layers or crust/facet combinations in a region of the snowpack that did not necessarily have a measurable tem- perature gradient indicative of kinetic snow metamorphism. (Jamieson et al. 2001, Greene & Johnson 2002, and others)

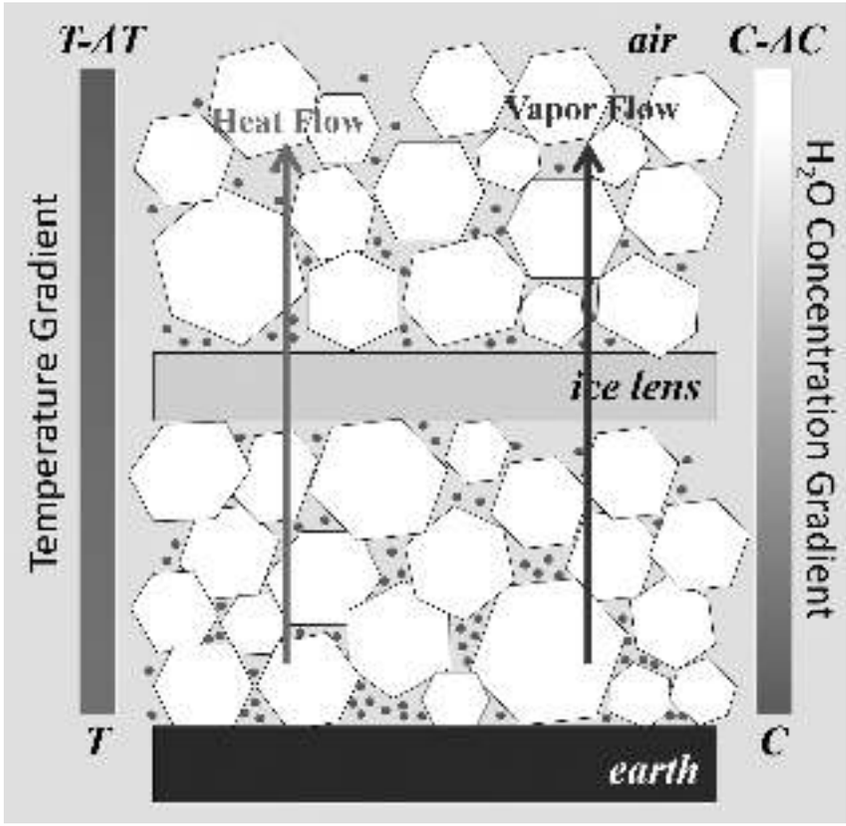
FIG. 2: SCANNING ELECTRON MICROSCOPE IMAGES SHOW (A) ICE CRYSTAL GROWTH ON THE BOTTOM SURFACE OF THE ICE LENS, (B) SMOOTHNESS OF THE TOP SURFACE OF THE ICE LENS, AND (C) KINETIC SNOW METAMORPHISM OF AN ADJACENT SNOW GRAIN ABOVE THE ICE LENS AFTER 48 HOURS UNDER A -100 °C/M TEMPERATURE GRADIENT. FIGURE ADAPTED FROM HAMMONDS ET AL. 2015.



2. Hammonds et al. (2015) showed that very large increases in the temperature gradient occur at very small scales in the snowpack around ice crusts. Such localized jumps in the temperature gradient on a sub-millimeter scale are not currently measurable with standard field instrumentation. Most temperature probes are themselves two millimeters in diameter and the typical resolution of a good dial-stem thermometer is +/- 0.5 °C.

"What causes the jumps in the local temperature gradient near the ice-snow interface?" This occurs because such icy layers can act as thermal discontinuities to an otherwise thermodynamically homogeneous snowpack. Such results are not exactly intuitive. "Isn't snow just made of ice?" The answer is "yes," but due to the crystalline structure and long range atomic order of solid ice versus the more disordered and loosely packed icy version of what we know as snow, thermal conductivities of ice compared to snow can differ by as much as a full order of magnitude (Petrenko & Whitworth 1999, Riche & Schneebeli 2013).This causes problems when individual snow grains come into contact with solid ice, as the pathway for conduction through the snow/ice matrix is compromised by the finite number of contact points that actually exist between the two, termed the thermal contact resistance.A function of the connectivity between the ice lens and the adjacent snow layers, the thermal contact resistance has been shown in a secondary study (Hammonds & Baker 2016) to be ultimately what is responsible for the marked increases in the sub-millimeter scale temperature gradients observed near the ice-snow interface.

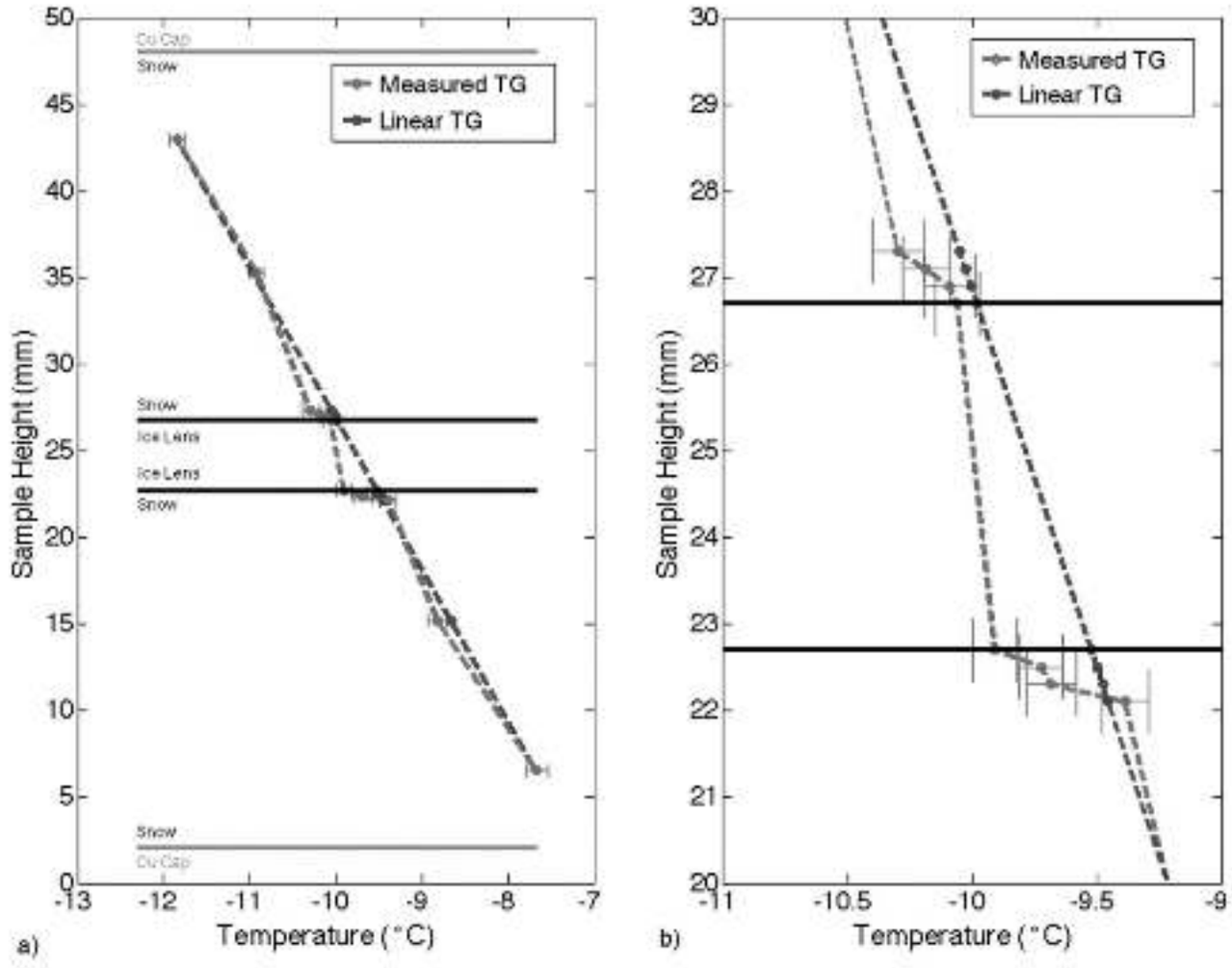
FIG. 1: FUNDAMENTALS OF THE ICE/SNOW INTERFACE: PHENOMENOLOGICAL REPRESENTATION OF HOW AN ICE LENS MAY AFFECT THE THERMOPHYSICAL PROPERTIES OF AN ICE-SNOW INTERFACE. DEVELOPING A BETTER UNDERSTANDING OF WHAT HAPPENS TO THE HEAT AND VAPOR FLUX AT THE ICE-SNOW INTERFACE WAS THE MOTIVATION BEHIND HAMMONDS ET AL. 2015.



Although never before directly measured, many have suggested in the past (Colbeck 1991, Colbeck & Jamieson 2001, Greene 2007, and others) that such super-temperature gradients were likely to exist near an ice-snow interface and that enhancements in kinetic snow metamorphism could result.As a pertinent and memorable example of this scenario, large and widespread avalanche cycles associated with the Martin Luther King (MLK) rain crust in 2011 (see *TARVol. 30 No. 3*) were more than likely the result of such enhancements in kinetic snow metamorphism occurring near the ice-snow interface.This MLK crust was observed to be a repeat offender as it would avalanche and then reload with a new snow slab.This is thought to have occurred because once formed, such ice lenses can only degenerate by the natural mechanisms of sublimation (slowest), destruction by an avalanche (fastest), or by becoming so significantly buried that compressional forces of the overlying snow slab aid in the bonding of the adjacent snow layers to the icy layer itself, thus limiting the effects of thermal contact resistance (most unsure and unsettling scenario).

So, to answer the question "Is it always worth getting a perfect every-ten-centimetre temperature profile in your snowpit?"The answer is quite simply "No." In fact, focusing too much on such large-scale temperature gradients can even be misleading as it may add bias to your opinion of what your observations of grain type actually mean. For instance, if you measure a bulk temperature gradient less than -10°C/m and identify a faceted crystal structure, it becomes very easy to assume the regime of "facets-going-to-rounds", when it may actually be the opposite that is occurring. Thus, based on physical evidence from recent laboratory testing (Hammonds et al 2015) that is in direct support of long-standing avalanche theory (Colbeck 1991, Colbeck & Jamieson 2001), it would seem most advantageous for us all to begin spending less time looking at our temperature plots and perhaps more time looking through the lenses of our loupes.

FIG. 3: TEMPERATURE GRADIENT MEASUREMENTS TAKEN WITH A MICROTHERMOCOUPLE ARRAY NEAR A 4 MM ICE LENS OVER (A) THE ENTIRE HEIGHT OF THE SAMPLE, AND (B) WITHIN ONE MILLIMETER OF THE TOP AND BOTTOM SURFACE OF THE ICE LENS. FIGURE ADAPTED FROM HAMMONDS ET AL. 2015.



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Avalanche Canada Mountain Weather Forecast **UPDATE**

Matt MacDonald

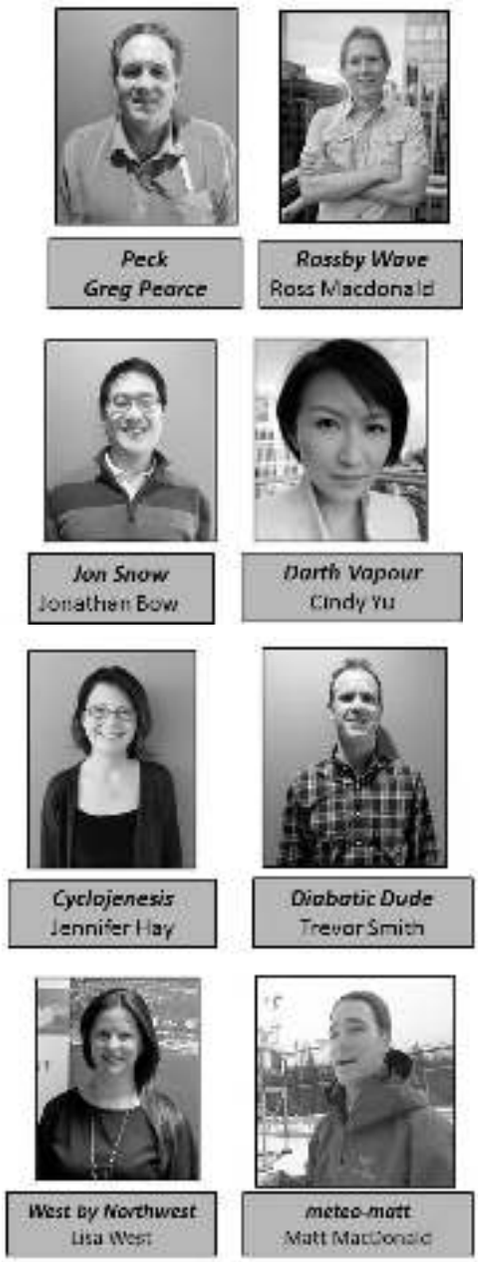
THE METEOROLOGICAL SERVICE of Canada (MSC) has been providing weather support for public avalanche safety since the 1980s. A specialized mountain weather forecast known as the "CPCN63," was a text-only forecast bulletin in all caps. Produced daily by meteorologists at the Pacific Storm Prediction Centre in Vancouver, BC., CPCN63 was only available to Avalanche Canada forecasters and InfoEx subscribers.

In response to requests from Avalanche Canada and avalanche professionals in western Canada, MSC completed a full redesign of the mountain forecast and rolled out the publicly available Avalanche Canada Mountain Weather Forecast (ACMWF) in the fall of 2014. Complete with MSC forecaster commentary, annotated surface charts, radar and a full suite of numerical weather prediction imagery and prognostic charts, the ACMWF was the result of tireless development and design hours by a team of MSC meteorologists and the IT staff at Avalanche Canada.

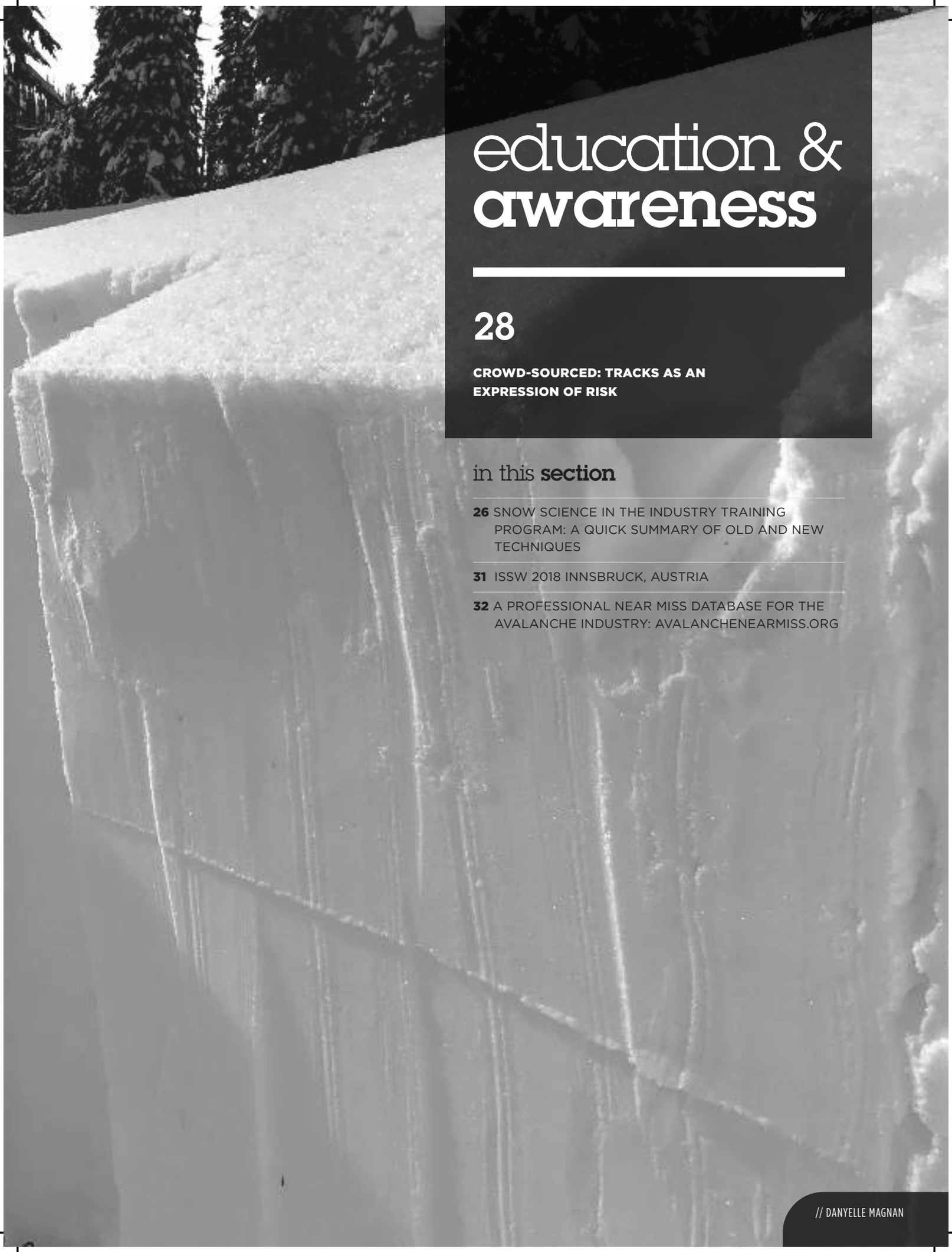
Now in its fourth season, the ACMWF and its content continue to mature and improve. In the spring of 2017, a survey was sent out to CAA and ACMG professionals to solicit feedback on the ACMWF. Over 200 professionals responded and the results were presented at the 2017 CAA AGM in Penticton. The feedback was generally positive, yet a clear and consistent message was that the ACMWF was too coast-centric. The avalanche community also expressed interest in an extended weather discussion beyond the day 1-4 period.

In an effort to include more Rockies and east-slopes of Alberta content, Pacific Storm Prediction Centre (PSPC) meteorologists returned to the drawing board and explored collaboration options with their colleagues at the Prairie and Arctic Storm Prediction Centre (PASPC) in Edmonton. After examining various solutions, PSPC and PASPC meteorologists are now exchanging ideas and collaborating on the weather depictions and description surrounding the Rockies on a daily basis. This winter marks the first season of a jointly produced ACMWF between PSPC and PASPC meteorologists. Via daily morning conference calls and webinars, PSPC and PASPC forecasters are endeavoring to shift our analysis and prognostic focus eastwards in an effort to be more inclusive of our Rockies clients.

The ACMWF is the brainchild of now retired MSC meteorologist David Jones and a team including Trevor Smith, Matt MacDonald, Ford Doherty, Andre Besson, Ross Macdonald and several other PSPC meteorologists who produce the ACMWF on a daily basis. Key staff at Avalanche Canada who pushed and encouraged MSC include Karl Klassen, James Floyer and their tireless IT staff Karl Guillote and Will Harding.



THE ACMWF IS THE BRAINCHILD OF NOW RETIRED MSC METEOROLOGIST DAVID JONES. HERE ARE THE MSC FORECASTERS BEHIND THE SCENES CREATING THE ACMWF.



education & **awareness**

28

CROWD-SOURCED: TRACKS AS AN EXPRESSION OF RISK

in this **section**

// DANYELLE MAGNAN

Snow Science in the Industry Training Program: **A Quick Summary of New and Old Techniques**

Emily Grady

WITH RECENT FINDINGS in snow science research and a renewed focus on techniques that are "falling out of fashion", the Industry Training Program (ITP) is changing up some of its approaches to instruction on snow study.

SNOW SURFACE TEMPERATURES

In the CAA's Observation Guidelines and Recording Standards for Weather, Snowpack, and Avalanches (OGRS 2016), snow study plot observations and field procedures for digging full snow profiles include measuring the snow surface temperature. This is done by "placing the thermometer on the snow surface and shading the thermometer."[1] The rationale behind this measurement is to observe surface conditions and to determine whether a temperature gradient exists between the surface and 10 cm down into the snowpack.

Based on current research by Bruce Jamieson and Michael Schirmer[2] it's evident that, even with shovel shading, there are errors of up to 6 degrees Celsius when snow surface temperatures are measured with contact thermometers. More accurate measurements are obtained with hand-held infrared thermometers; however, the use of these in many winter operations is challenging (for example ski guiding).

Also noted in their technical paper[2], Jamieson & Schirmer identified that "inferring the near surface faceting from a point-in-time surface temperature measurement (even with an IR thermometer), and a snow temperature measurement 10 cm below the snow surface, is inferior to a few observations of the sky condition (J. Schweizer, pers. comm., 2016)."

Based on this research, instructors on avalanche operations level 1 and 2 courses will no longer be teaching students to measure snow surface temperatures with a contact thermometer. They will be emphasizing:

- observing sky conditions
- manually observing snow surface conditions and grains with a loupe and crystal screen
- measuring temperatures down 10cm

The above observations are all better indicators of processes at and near the snow surface than measuring the snow surface temperature, especially when this measurement is done with a contact thermometer. For example, the clearer the sky, the more surface cooling occurs, thereby creating a greater temperature gradient near the surface, and an increased likelihood of near surface faceting.It is anticipated that OGRS will be updated to reflect this change in the near future.

WATER EQUIVALENCY

The importance of measuring density and determining water equivalency has been in the limelight recently. Water equivalency was discussed at the 2017 CAA instructor spring meeting and was the topic of a well-written article by Karl Klassen, *The Weight of Water*[3], published in the previous issue of *The Avalanche Journal* (vol 116).

According to OGRS 20161, "water equivalent is the depth of the layer of water that would form if the snow on the board melted. It is equal to the amount of precipitation "if the snow were to have fallen as rain and is measured in millimeters (sic)." Because the density of snow varies significantly, calculating the water equivalent provides an important clue as to how much load exists or has been added over an old surface or weak layer and, as Klassen states, this ultimately "helps to determine how close the snowpack is to the tipping point between stability and instability ."

In other words, load (as expressed in mm of water equivalent) is an essential factor in determining avalanche likelihood (instability); this is information that new or snow depth in centimetres alone lacks. Therefore, it's important that avalanche practitioners be familiar with measuring water equivalency and tracking loads over weak layers. With this in mind, the following will be done on ITP courses:

1. Avalanche Operations Level 1 – water equivalency will continue to be measured in the study plot. Instructors will also be demonstrating how density is measured in the field and spending more time emphasizing the importance of determining water equivalency.

[1]*Observation Guidelines and Recording Standards for Weather, Snowpack, and Avalanches* (2016) Canadian Avalanche Association.
[2]Jamieson, B. & Schirmer (2016). M. *Measuring Snow Surface Temperatures: Why, Why Not, and How?* Revised from Proceedings of the 2016 International Snow Science Workshop.
[3]Klassen, K. (2017). *The Weight of Water.* Canadian Avalanche Association. The Avalanche Journal Fall 2017 edition.

2. Avalanche Operations Level 2 - water equivalency will continue to be measured in the study plot. Instructors will also continue to emphasize the importance of determining water equivalency and have students measure relevant densities in the field for full snow profiles. Snow density kits are now a recommended equipment for Level 2 students.

SUMMARY

ITP attempts to stay current in best practices by incorporating findings in new and proven research, as well as resurfacing techniques that have fallen out of use. The measuring of snow surface temperatures is an example of the former, while calculating water equivalency falls into the latter category. The result is an injection into the avalanche industry of recent avalanche operations graduates with up-to-date techniques and knowledge that better serves the community.

Questions relating to these changes and any other ITP curriculum may be directed to Emily Grady egrady@avalancheassociation.ca.

INSTRUCTORS WILL BE DEMONSTRATING HOW DENSITY IS MEASURED IN THE FIELD AND SPEND MORE TIME EMPHASIZING THE IMPORTANCE OF DETERMINING WATER EQUIVALENCY. PHOTOS: STEVE CONGER

// JORDY HNEDRIKX

Crowd-Sourced: Tracks as an Expression of Risk

Jordy Hendrikx and Jerry Johnson

"WHEN THE SNOWPACK IS YOUR PROBLEM, terrain is your solution". This widely used avalanche education and avalanche mitigation concept stresses the idea that by using appropriate terrain, a backcountry traveler can avoid snowpack instability and thereby minimize avalanche risk. The notion is well entrenched in our management of avalanche risk, as operationalized in Canada by the avalanche terrain exposure scale (ATES) and the associated Avaluator™ trip planner (Haegeli, 2010) for self-directed backcountry travelers. Furthermore, this terrain based approach has also been adopted (in a modified format) for industrial applications, where the level of training of the group leader provides acceptable terrain use, as defined by ATES, under varying avalanche danger (Canadian Avalanche Association, 2016). Viewed in this way, terrain use is an efficient expression of risk in the avalanche patch.

Our group has been working on a variety of approaches to track and analyze terrain use by backcountry skiers and riders where GPS tracks are used as evidence of a cascade of decisions. As travelers move across the landscape, the track is a literal footprint of their management of terrain, snowpack, trip goals, group dynamics and barriers. By understanding their track, and the group(s) that are making these tracks, then we can better understand real-world avalanche risk mitigation decisions. This will ultimately inform avalanche education and reduce accidents.

Our first project to investigate these issues started in 2013 and was termed 'SkiTracks' (Hendrikx et al., 2013). This project collected GPS location information and survey responses from backcountry travelers (skiers/riders/sledders) to better understand what types of terrain decisions people make. Following a few seasons of trial and error, including using hand-held GPS units and paper log books, we moved into the smartphone world and developed a fully integrated methodology where all survey data and GPS tracking is accomplished with technology we all carry. This, combined with improved communication from us, and assistance from the avalanche forecasting centers, led to a substantial uptick in tracks being submitted (Hendrikx and Johnson, 2014; 2016a; 2016b). An overview video of the SkiTracks project can be viewed on YouTube.

These data have provided critical information about our participants' terrain use as a function of: experience; group size; avalanche danger rating; group decision

making; and the role of some potential heuristic traps (e.g. slope familiarity) (Hendrikx and Johnson, 2016a). We also examined the differences between sled tracks and ski tracks, and while not hugely surprising, found that while the percentage of time sleds spend in avalanche terrain is far less than that for skiers/riders, the number of individual avalanche features and distances they travel is substantially greater. Furthermore, a temporal analysis of the positions of multiple sledders in one group indicated a greater length of time that sledders were out of view from one another—up to 6 minutes. This has implications for a successful search in the case of a complete burial (Hendrikx and Johnson, 2016b). Similar to the recent work by Thumlert and Haegeli (2017), we have also employed the GPS tracking and survey approach to look at professional decision making by heli ski guides (Hendrikx et al., 2016; Hendrikx and Johnson, 2016c).

While our crowd-sourcing approach has yielded us with some incredible data, from thousands of backcountry trips from around the world, the data is clearly not representative of the entire population of backcountry travelers. A participant in our sample is well motivated to be involved. They complete a pre-season survey, GPS track their trip on their smart phone (or GPS), submit this to us, and also participate in a post-trip survey.

Why do some people elect to expose themselves to risk, and what are the range of motivations? While some are well equipped to manage higher levels of risk, do others unknowingly put themselves in danger?

Not everyone is so engaged. Working with Master candidate Diana Saly, passive data collection methods were employed. She tracked backcountry travelers entering a backcountry area adjacent to Bridger Bowl ski area in SW Montana (Saly et al., 2016) by using a time-lapse camera. The camera was stationed on an unused gun mount with good visibility into the backcountry area. Programmed to take photos every 10 seconds during daylight hours, Saly was able to track and observe terrain use by every visible party, as compared to volunteer participants. Comparing these two populations will provide insight on the impact of our sample population, as well as further understanding into terrain use by people in backcountry areas proximal to a ski area boundary.

While the time-lapse camera data is extremely rich with respect to capturing terrain use by backcountry travelers, it is an incomplete profile. For example, skills and motivation behind the terrain use is not recorded. We cannot assemble cohorts of backcountry travelers into who uses the riskiest terrain, how much education do they have, do they know the regional avalanche forecast?

To add another layer of understanding, we started a third project, with Master candidate John Sykes, to conduct intercept surveys and GPS tracking on the boundary line at Bridger Bowl. From this combined approach we can begin to understand who goes into the backcountry, where they travel, and how their behaviour may change as a function of individual factors, group factors, and snow and avalanche factors. This information will improve understanding of terrain use, and can be used to tailor avalanche education (based on demographic cohorts), in particular for problem areas like backcountry adjacent to ski areas.

While these projects are clearly providing us with critical insights on terrain use in the backcountry, by a wide range of users, under varying conditions, we are still missing a critical component. This component is a fuller understanding of why. Why do some people elect to expose themselves to risk, and what are the range of motivations? While some are well equipped to manage higher levels of risk, do others unknowingly put themselves in danger? By segmenting the skier populations, we can design better education and approaches.

A new project, named the White Heat Tracks project, is an extension of SkiTracks. Funded by the Norwegian Research Council, White Heat Tracks is collaboration between a group of researchers at UiT, the Arctic University of Norway, in Tromsø; Montana State University, in Bozeman, USA; and Umeå University, in Umeå, Sweden. The aim of White Heat is to generate new and usable knowledge on excessive risk-taking behavior in general, and on factors behind decision errors in avalanche terrain in particular. Results from a pilot project were recently published in *Bergundsteigen* (Mannberg et al., 2017). More information can be found on the Montana State University website, under snow science.

Our work is still ongoing. Next time you are out touring, have a look at your track and ask yourself, what does it tell about your motivations and decision-making processes? Could you have used the terrain better to minimize your risk? Consider sending your findings in to our team. **We need your help and encourage you to become a participant!**

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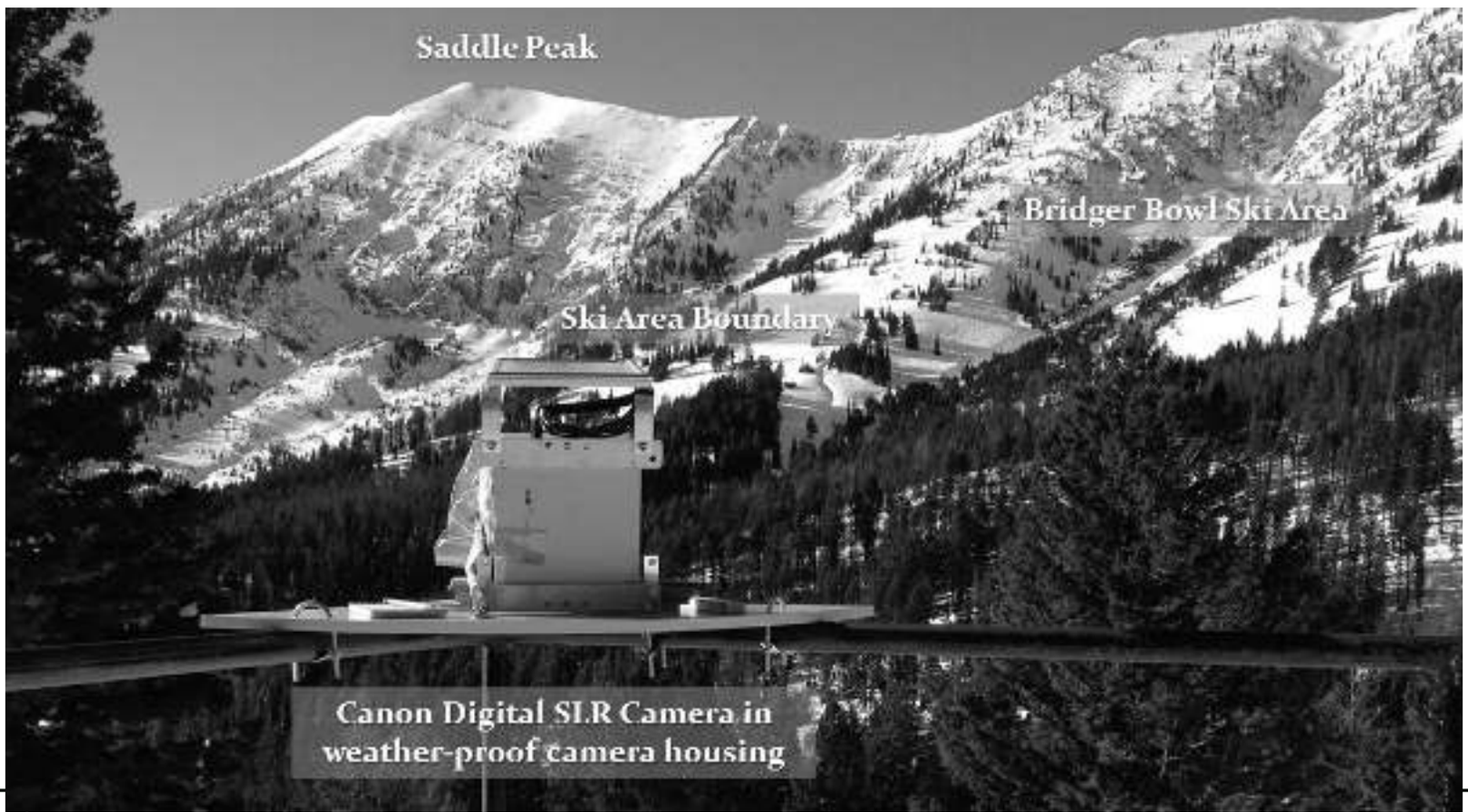
TIME-LAPSE CAMERA WAS STATIONED ON AN UNUSED GUN MOUNT WITH GOOD VISIBILITY INTO THE BACKCOUNTRY AREA. PHOTO: DIANA SALY



// HANNA KRISMER

ISSW 2018 Innsbruck, Austria - October 7-12, 2018

Susan Hairsine

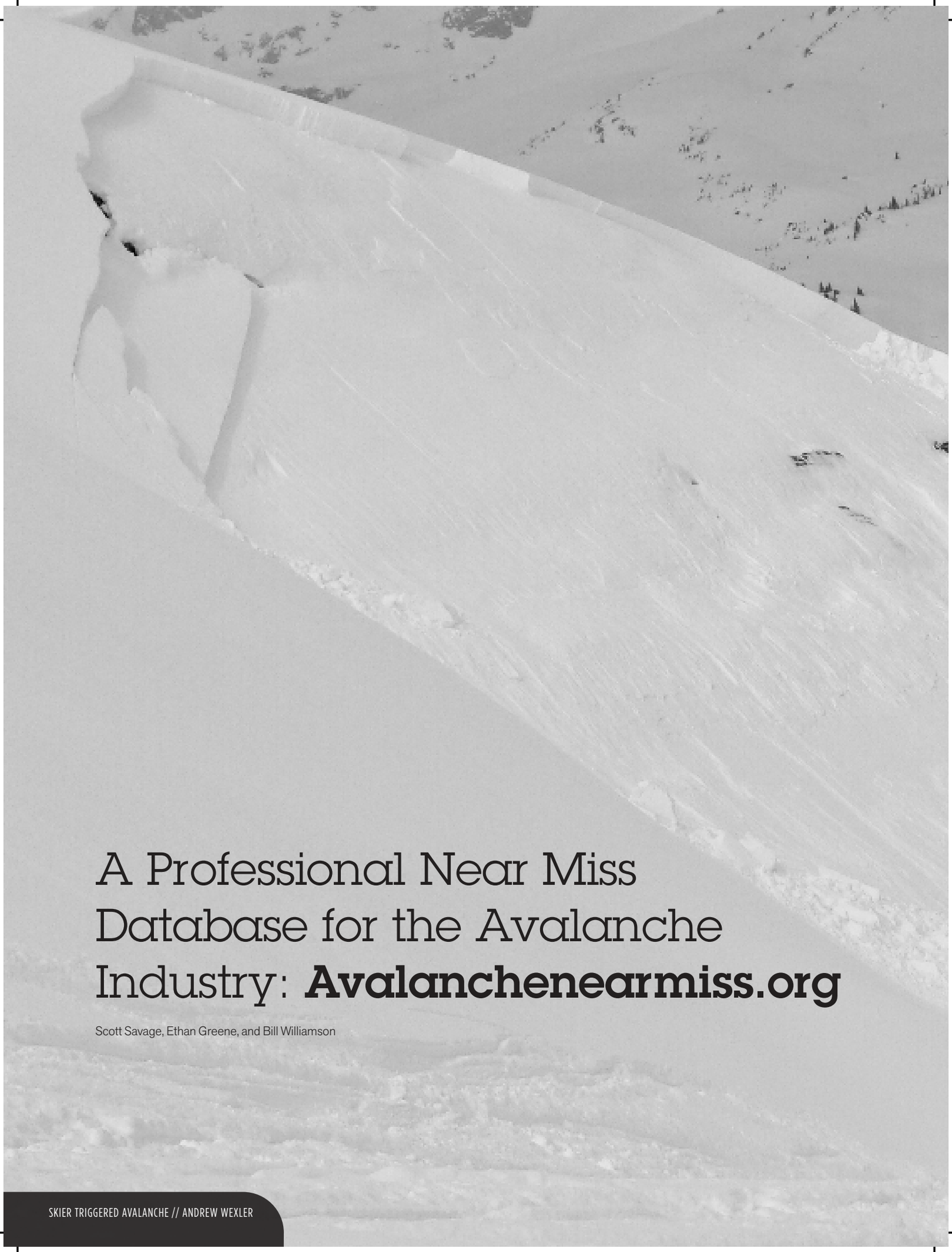
A YEAR BEFORE ISSW 2018, Kelly Elder (team USA) and Susan Hairsine (representing team Canada) were invited to attend an ISSW Organizing Committee meeting in Innsbruck. This will be the first time ISSW is included in the regular ISSW biannual rotation (Canada, USA, Europe).

The tentative schedule includes daily themes featuring a general topic, and afternoon sessions geared to special topics and some training opportunities. Live translation in four languages will be conducted during the morning sessions. The preliminary schedule includes snow and avalanche dynamics, protection measures, risk management and engineering solutions, snow hydrology, sustainability and climate change, snow making and ski resort management on the first two days. Following recent ISSW protocol, day three includes field trips, networking opportunities and offerings for the general public and media. Day four and five include snowpack stability and variability, avalanche forecasting, rescue and crisis management, education, communication, guiding and risk management strategies. The topics may shift slightly as planning continues, abstracts are received, and the program is finalized. Attempts are being made to include a strong practitioner presence and the breakout sessions and trainings will have that focus. Practitioners from Europe have played a strong role in the planning process.

We toured the Innsbruck Congress, the conference centre, where the daily sessions will be held. The building is spectacular with lots of windows and big spaces to take in the amazing views Innsbruck has to offer. The Congress is only steps from the old city of Innsbruck and at the base of the Nordkette where a gondola and cable car can transport you (and a bike if you want) to 2200 meters and one of the steepest single-track mountain bike trails we've ever seen. Or, you could rent an electric mountain bike and power your way to the top. Innsbruck offers endless adventures in a spectacular mountain setting, with easy transportation options for exploration.

ISSW 2018 is being organized by the Austrian Research Centre for Forests, Avalanche Warning Service Tyrol, Austrian Service for Torrent and Avalanche Control and the Tirolean Mountain Guides Association. The team is pictured here. This is a fabulous time of year to visit Austria and Europe so consider extending you visit on either side of the ISSW to take advantage of the trip overseas. Every attempt is being made to keep conference costs low to make this ISSW accessible to all. It's sure to be a great ISSW in Austria!

Visit http://www.issw2018.com/en/ for more information and register for the information emails.



A Professional Near Miss Database for the Avalanche Industry: **Avalanchenearmiss.org**

Scott Savage, Ethan Greene, and Bill Williamson

SKIER TRIGGERED AVALANCHE // ANDREW WEXLER

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

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

Avalanchenearmiss.org collects information on workplace near misses and accidents involving avalanche workers. Each submission is reviewed by a volunteer moderator. The moderator will remove any information that identifies the people, organization, or location involved in the incident, ensuring the published reports are completely anonymous. Reviewed reports are available for anyone to read - no subscriptions or logins. There are basic search functions and filters to help find pertinent reports. More advanced reports and tools will come online as the database grows.

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

We need your help! Please visit avalanchenearmiss.org, read the reports, submit your stories. This project will be as good as you – the professional avalanche community – make it. The ultimate goal is to learn from each other's near misses.

FAQ'S:

- Where do I go to tell my stories or to learn more about this project? www.avalanchenearmiss.org
- Can I enter close calls or near misses that don't involve avalanches? Yes, the platform is setup to accept any workplace near miss (e.g. transportation, aviation, etc)
- Can I enter accidents that happened years ago? Yes, we hope that people will submit experiences from throughout their careers. The more reports the better.
- What if I don't know the date a near miss occurred? Guess. Inaccurate dates will not affect this project. If you're missing a few specific details (date, weather, snowfall amounts, etc), don't sweat it - tell us what you do remember. We want your stories and what you learned.
- I'm worried I'll get in trouble at work for submitting events - will I? We don't want to get you in trouble! Please do not participate without first getting the OK from your operation or supervisor. Many operations are thrilled to participate, but some may choose not to take advantage of this resource.
- Are the reports anonymous? Yes. As soon as a volunteer moderator has reviewed your report, and entered it into the database, any contact information you provided will be deleted. Published reports are anonymous. The only identifying information we collect are snow climate and industry sector.

SKIER ACCIDENTAL // JORDY SHEPHERD

Schedule of Upcoming **Events**

BC TOURISM INDUSTRY CONFERENCE
March 7-9, 2018
Kelowna, BC
Together Towards Tomorrow
For more information:
info@bctourismconference.ca

EUROPEAN GEOSCIENCES UNION GENERAL ASSEMBLY
April 8-13, 2018
Vienna, Austria
Brining together geoscientists from all over the world to one meeting covering all disciplines of the Earth, planetary and space sciences.
For more information:
www.egu2018.eu

WESTERN SNOW CONFERENCE
April 16-19, 2018
Albuquerque, NM
A forum for individuals and organizations to share scientific, management, and socio-political information on snow and runoff from any viewpoint and advances snow and hydrologic sciences.
For more information:
westernsnowconference.org

HELICAT CANADA SPRING MEETING
April 30, 2018
Penticton, BC
A gather to discuss common issues and challenges, learn from our shared experiences and explore exciting new trends.
For more information:
http://www.helicat.org/spring-meeting/

CAA SPRING CONFERENCE AND ANNUAL GENERAL MEETING
April 30-May 4, 2018
Penticton, BC
Join us for the AGM, meetings, case study and research presentations and discussions about the Canadian avalanche industry.
For more information:
www.avalancheassociation.ca/page/SpringMeeting2018

WILDERNESS RISK MANAGEMENT CONFERENCE
October 3-5, 2018
Portland, OR
Gain practical risk management skills, network with others in the industry.
For more information:
www.nols.edu/en/courses/risk-services/wilderness-risk-management-conference/

ISSW 2018
October 7-12, 2018
Innsbruck, Austria
A Merging of Theory and Practice.
For more information:
issw2018.com/en

New Transceiver Training Videos from BCA

Backcountry Access has released a series of videos on how to use transceivers—from the basics of following flux lines all the way up to "how to pass a guiding exam." Even better, they're downloadable from BCA's website, so you can use them when teaching courses. BCA has given permission for avalanche instructors to use them freely.

Go to BCA's Videos page backcountryaccess.com/portfolio-category/avalanche-safety-videos and click through the individual videos. There will be a link for you download each one.

In addition, BCA has a full lineup of downloadable videos on avalanche avoidance and rescue. Please see their Backcountry Basics and Companion Rescue series on the BCA Education page.

avalanche **community**

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REDUX: MT SEYMOUR PARK AVALANCHE TASK

in this **section**

// WREN MCELROY

Redux: Mt Seymour Park Avalanche Task

Scott Aitkin

EDITOR'S NOTE: This began with an email from Scotty to me:
Dear Jill,
It's over ten years now since I went as District Avalanche Technician, Coast Chilcotin Avalanche Program to Mt Seymour Park in support of North Shore Rescue who were "in a bit of a pickle," according the voicemail on my phone. So today, retired after 31 years in the public service, I kinda giggle at both the memory of the day (truly all-time top five for fun and camaraderie) and recognizing my own writing style - long and subsidized.
Days like the one at Theta Lake Staircase and numerous other happy ending SAR tasks sorta balance out a lifetime body bag count now north of 20. I pulled back a bit last spring after the stress of double rescue leadership roles at Hanging Lake and Mt Harvey. "I'm just not going to dig for a while," is what I told the team and myself. I see that traumatic stress retreating. Coming across this article made me think it's a good one to share.

Some extra notes omitted from the original article, written for our Ministry newsletter, *The Road Runner*:
- I had an early morning adrenaline shot when, driving down Hwy #99 in pouring rain with explosives in the back of the yellow truck, I exited a reflectorized and well-marked construction zone (pre-2010 games), into near total darkness of Howe Sound at 6am. Not even a centre line on the highway to be seen. Brad and I for a heartbeat thought I had driven off the highway into an abyss. Yikes!
- Human factors contributed to a near miss; not asserting myself to pull a team member more senior in my eyes.

MT SEYMOUR PARK AVALANCHE TASK

Reprinted from *Road Runner*, Spring 2007, courtesy of the Ministry of Transportation and Infrastructure.

"HI SCOTT. IT'S BRUCE. We're in a bit of a pickle here." The voicemail was from a fellow avalanche rescue dog handler (CARDA), friend and wilderness paramedic. It explained why my pager had come to life on a January afternoon as we returned from field work in Cayoosh Pass and into cell range.

A call-in reply quickly briefed me what the pickle jar looked like. North Shore Rescue teams (NSR) and a snowshoer with multiple injuries were hunkering down for second night bivouacked out in heavy snow and high avalanche danger in Mt Seymour Provincial Park. Canadian Forces 442 Rescue Squadron Cormorant helicopter crew had stood down after one attempt the previous day due to worsening weather.

The team's location at Theta Lake was not far from the ski hill base, but separated by 300 vertical metres of heinous avalanche terrain down which the subject had fallen. Paramedics had stabilized Chris Corey, a lucky 36-year-old Coquitlam man and father of three as darkness fell the previous night. No helicopter extraction appeared likely soon as foul, wet, hypothermia inducing foggy weather lingered on the North Shore Mountains. Rationing had commenced of the limited fuel supply. Bruce, John, Doug, Rolly, Tim and Gord weren't yet in peril but they weren't getting any drier either. To exacerbate things, there were fewer sleeping bags than rescuers.

Rapidly increasing avalanche danger had shut down the rope rescue on Day 2. One of the most experienced rescuers, Dave, had "gone for a ride" in an avalanche on a mercifully short slope. Camp was moved when a naturally triggered avalanche stopped five feet from the team in their snow shelter. "What was that?" asked Chris when the avalanche stopped. "Mother Nature," replied Tim Jones, NSR team leader.

Bruce's call was to request a professional avalanche control team response to blast and establish a safe rope rescue corridor out of Theta Lake. "Let's see," I think. High avalanche danger, mountain terrain shrouded in heavy wet snow, numerous rescue personnel including snowmobiles to control, and huge decision-making pressure with a national media presence if we screw up with our explosives...

"Sure we'll be there at 7 a.m.," I tell Bruce. This is a fairly routine task for an avalanche technician and I'm confident I can get there with my tools.

MoT snow avalanche programs have made high-reliability an organizational principle. HQ has made managing the unexpected easier for me today by forming a pre-plan which includes an MOU with Provincial Emergency Program (PEP) to provide expertise in response to avalanche related SAR tasks. I've also got a new yellow ¾-ton pickup equipped to haul explosives.

TARP CITY SETUP FOR THE OVERNIGHT SHELTER

My program's explosives are a two-hour round trip away, so I request Bruce to contact Whistler Blackcomb Resort for more resources. When he calls back we conference with Dave Sulina, briefing me thoroughly enough to make a pre-plan.

Friday January 12, 0315 hrs and I am fairly well rested. This stormy avalanche season has provided practice in early sleeps for early starts! It's more comfortable making this double coffee than if I had just spent a second night busted up in a snow cave in the forest, I tell myself. Moderate snow falls outside while breakfast is eaten in silence in Whistler minus the morning news. I consider the weather forecast and what my avalanche briefing with NSR had told me. A weak layer of surface hoar crystals sitting under a 70 cm slab of wind driven storm snow is not good. Put this combination over an old ice crust and the result is perfect high avalanche danger day. Crew safety today is my first and foremost concern. This snowpack should react to explosive triggers. That's good.

I meet with the team at 0430 hrs, all pros from Blackcomb Mountain Ski Patrol including friends Nigel Stewart and Ken Nickel. Andrew "Haggis" Haig, and Jack Hurtabies sled up to the explosives magazine on Blackcomb and join us with ten explosive hand charges (shots) while I do dangerous goods transport paperwork with "Cog" the patrol director. Will this be enough? We'll see if it's more than less. I rib sleepy looking Ken about his young girlfriend not letting him sleep enough this am. The crew was called in from days off and typically upbeat.

I've radioed and phoned the road crew for Duffey Lake – Bridge River for a snowfall updates of my own avalanche patch the Coast - Chilcotin and updated my supervisor, Brian Atkins. The dry side of the Coast Mountains is lightly dusted today. I'm good to go. Now Whistler SAR manager Brad Sills and I will drive south to meet 40 or 60 other SAR members at Mt Seymour Ski Hill.

Doug Tuck, Assistant Avalanche Technician will be in at 0700 and out for a road patrol to cover our Highway #99 Rd #40 responsibilities. The sea to sky corridor avalanche forecast is priority. Decker, my CARDA dog, sleeps away in the back seat. It's routine for him, and I guess for me too. So why is my stomach doing flip flops as we drive south in the rain? Best eat some more food for the long day in the snow whether the gut wants it or not.

The trip through the Sea 2 Sky construction is uneventful other than the CBC radio news which we, the 'avalanche experts' are now part of. I haven't been in Mt Seymour Provincial Park for, let's see, 23 years. We get to the foggy ski hill parking lot and NSR's mobile command post the 'Batmobile' is buried to nearly the top of its wheels in storm snow. I let Decker out for a squirt behind the patrol room turned search base. A NSR member guards the explosives. It's time to get briefed, look at maps, and make a plan. These folks are organized which is good. I suit up in MoT issue outerwear. Ten 1kg shots are transferred to team packs and we're off! No wait, the snowmobiles are getting unstuck. As the TV cameras roll we wait, talk, joke, and laugh. All's routine so far.

The sleds depart after quickly delivering us outside the ski area boundary. We probe the snow with our ski pole handles and feel the soft layers over the hard ice crust. This is our first clue as to today's stability.

It's quiet on the ski tour to the NSR advance base camp above our rope rescue corridor "The Staircase". The subject is only 1.5 km away from the ski lodge but it might as well be 10 km for the effort this steep task will take. A lot of resources are lined up behind us to make this happen. All the tools in the tool box are available.

HAPPY FAMILY

We confirm with Tim that he's in a totally safe place. I pull out the tools of my trade to do a test snow profile. The snow gives up instability clues under my shovel and snow saw: moderate compression test failing on the crust surface hoar combo and a mid-slab moist layer. It should go! I double check that Tim is in safe terrain. He fires a parachute flare up and it comes from a safe spot. That's good. Nigel's first shot rips out a size 2.5 slab avalanche and as the other rescuers recover their heart rates at the sudden bang, Tim reports the avalanche size at Theta Lake which is the runout zone.

Now I have the unpleasant task of telling Rob, BC Park Ranger, that this terrain is too 'sporty' for his skill level on telemark skis. He takes it well. Dave stays back too with his big pack directing the rope teams. Now we're a manageable team of six.

Okay, let's go cautiously and keep track of all team members. Every shot is releasing thick slabs of storm snow. Tim reports avalanche sizes on the radio. The team members are now moving to new shot placements. I again urge caution since we're now skiing on the icy crust which has shed its new snow load.

The pros move like mountain goats over the steep terrain between big trees. From above I hear a wild yell in panic from Brad and fear the next sound will be a body thud. All goes quiet except for his ski rattling down the gully to my right. He has self-arrested. Phew! That's good! He has followed Nigel's exploratory tracks instead of mine and blown a ski when he hit the crust. He'll climb back up a bit to his comfort zone and wait to direct rope teams. S**t! Why didn't I give him the hook with Rob? Why did he stray from my tracks? Follow the guide is rule one! "Situational awareness, Scotty," I tell myself. "Look back as well as ahead." That will be one to debrief, I think.

More shots yield more avalanches. Nigel and I take turns on point. We analyse the terrain, the hazards, and the path of least resistance, and direct where the shots go. Several times we retreat back up to a safer line and blast it clear when cliffs block our descent.

We're fully engaged, using all the mental and physical skills accrued over decades of avalanche work. It's still snowing and the cloud is on the deck. Occasionally we hear Peter Murray trying to pilot his A-STAR B2 helicopter in to Theta Lake and wrap up this task. He can't get past the white wall of wet coast weather. Noon passes with no thought of a lunch break. Then we throw our second last shot. We find an exit through a steep walled gully and the staircase A/C route goes. There's the lake and the avalanche debris in the run-out zone. We're in the clear! As we ski out, Andrew finds a broken tree top under the snow's surface. Pop goes his ski in

easy terrain and he thrashes downhill in soft snow. My stress lowers as we chuckle at his embarrassed pose and ski down to Theta Lake. Tim, with his head poking from an orange garbage bag, and the soggy rescue team emerge from the forest happy to see us. Brad's ski is recovered to be stashed with the camp gear and retrieved later. (And sharpened.)

Nigel lights our last shot's fuse and the detonation blackens the snow beside the heli spot to help Peter with landing reference in this white-on-white world. It's rest time and we chat, snack, and exchange information. I say hi to a bruised and broken Chris who's in good spirits and cracking jokes thanks in part to a recent morphine injection in his butt. Final diagnosis will include fractures to maxilla, mandible, wrist, and leg, as well as lost teeth and multiple contusions and lacerations. He fell so hard pinballing through the trees that he arrived at the bottom minus a boot and snowshoe and with a dislocated shoulder.

I count up the number of bums vs. helicopter seats and we'll be air lift number four. Not a chance today. We'll kick a line of steps back up the staircase route for the rescue team to follow. See ya! I listen to the weather forecast from base; not good but some hope for change around 1600 hrs. My team is already in single file boot hiking up, skis strapped to packs. I catch up and take my turn breaking trail bareheaded and sweating under a wet shell back to the top of the staircase.

I never actually see the helicopter half an hour later. Peter arrives and departs by tenaciously flying tree top to tree top, setting a line of way points on his GPS then retreating to ensure the weather window is still there behind him. Tim announces over the radio that Chris is airborne for the hospital after a "Vietnam style load & go." We all cheer! Tim's pride is in the helicopter as his son is the receiving flight paramedic on board. The overnight teams are going to boot hike out in our tracks and won't be out 'til after dark. Emotions bubble out of everyone involved. We're stoked! This is fun being out of our bubble, in new terrain, with a different crew.

We climb past Bruce who is setting up the rope raise. He grins and tells me Decker has been cared for by base team members. He is thorough as always, and I tell him his call was crucial. Ten more minutes and we top out and chat briefly with the camp team who give me a ham and cheese to go.

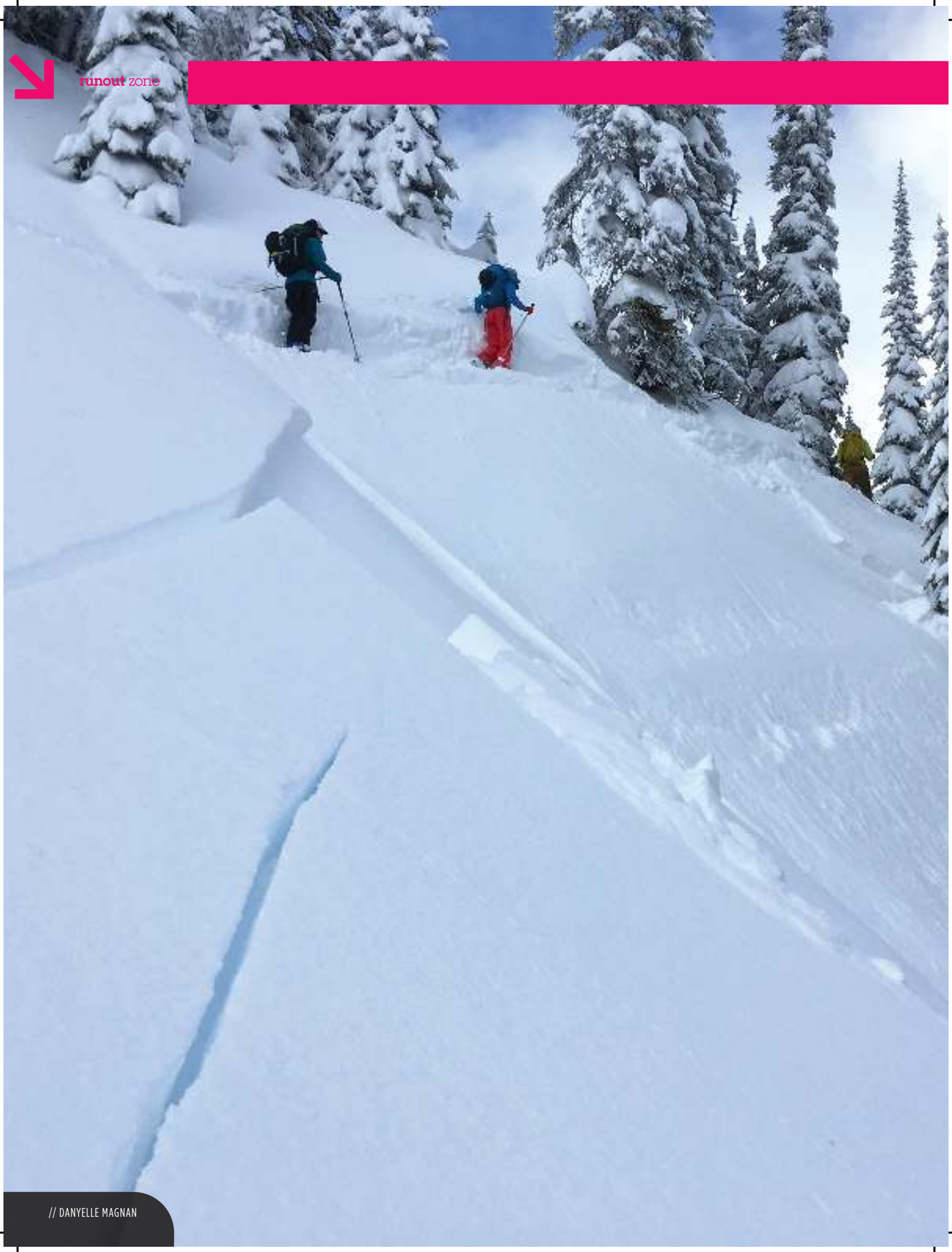
It's foggy and nearly dusk at the Batmobile and the media ignores us. We sign out and head home as CBC is reporting the successful conclusion, giving Peter the credit he deserves. Tim thanks me via cell phone call and I check-in with my understanding wife, Melissa, and MoT offices. The number of resources required for this task is sinking in to my wet consciousness. The size of this effort is not routine. Brad and I talk about his near miss. No place for a fifty-three-year-old he says.

The local Whistler paper, *The Pique*, prints a more sensationalized version:

"The Whistler-Blackcomb team, they just rock," said Don Jardine, a search manager for NSSR. "They just did a fantastic job, man, just so impressive. They dropped in on skis, bombing and blasting until they cleared the whole site down to where we had the patient… and basically, they stopped there, had a drink of water, shook hands, and they were off back up. It was like special-forces had parachuted in."

Why wasn't this an emergency? It was routine because we pre-plan and practice. Why? Because we're professionals.

DECKER WAITING FOR HIS MASTER // DOUG TUCK

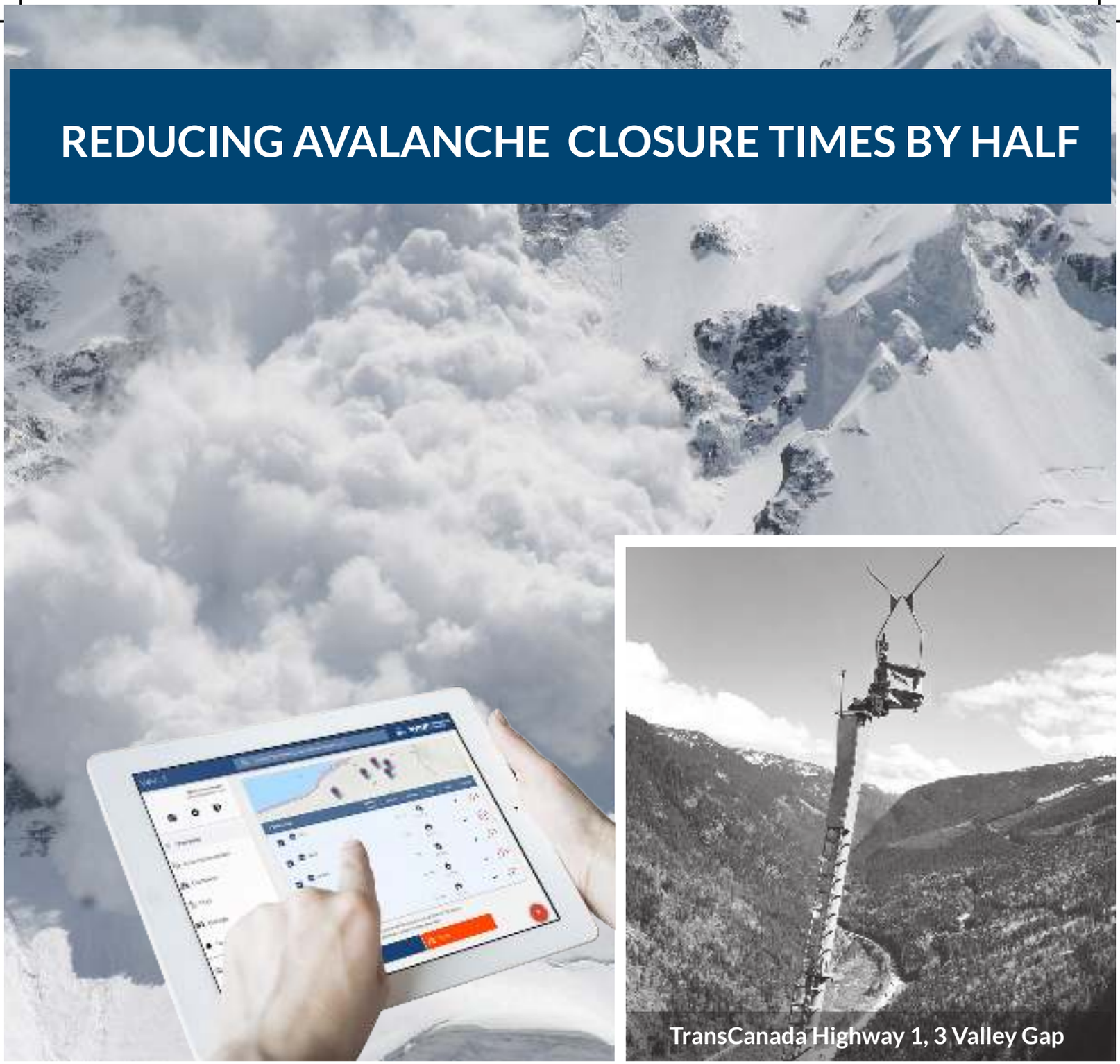


// DANYELLE MAGNAN

Flakes

ROB BUCHANAN

REDUCING AVALANCHE CLOSURE TIMES BY HALF



TransCanada Highway 1, 3 Valley Gap

SAFETY THROUGH INNOVATION

wyssen switzerland

avalanche control

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