

April 22, 2021

To:

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Ross Cloutier and Rob Rohn (HeliCat Canada)  
Joe Obad and Walter Bruns (Canadian Avalanche Association)  
Mike Wiegele, Bob Sayer and Elias Ortner (Mike Wiegele Helicopter Skiing)  
Gilles Valade and Kevin Seel (Avalanche Canada)  
Cheryl Goodwin and Kevin Williams (Avalanche Canada Foundation)

## **RE: 2020/21 Supporter Update of SFU Avalanche Research Program**

As for everybody else, that has been a rather unusual and turbulent year for the SFU Avalanche Research Program as we had to adapt our research plans and personal lives to COVID-19. However, we overall feel very fortunate and are grateful for the fact that we only had to change our research projects slightly and that COVID has so far not affected our funding situation.

On behalf of my entire research team and SFU, I would like to thank all the supporters and collaborating operations for their continued support of our research program during these challenging times. Our research would not be possible without your financial support and expert input. We are grateful for this support, and we are looking forward to continuing our work with the Canadian avalanche community.

The purpose of this document is to inform the supporters of the Simon Fraser University Avalanche Research Program (SARP), including the NSERC Industrial Research Chair in Avalanche Risk Management (IRC), about the activities accomplished by the research team between May 1, 2020 and April 30, 2021 and to provide a brief outlook on the planned activities for the next twelve months.

## 1 Team

Over the last year, the core SARP team consists of the following personnel:

- Dr. Pascal Haegeli (team leader)
- Dr. Simon Horton (postdoctoral fellow)
- John Sykes (PhD student in Geography)
- Florian Herla (PhD student in Geography)
- Stan Nowak (PhD student in SFU's Visual Analytics graduate program)
- Anne St Clair (PhD student in REM, rejoined in September 2020)
- Katie Fisher (MRM thesis student)
- Amélie Goulet-Boucher (MRM thesis student)
- Heather Hordowick (MRM thesis student)
- Abby Morgan (MRM project student)
- Rosie Langford (MRM thesis student since September 2020)

In addition, SARP includes the following affiliate members:

- Grant Statham, Parks Canada (adjunct professor)
- Dr. James Floyer, Avalanche Canada (adjunct professor)
- Dr. Patrick Mair, Harvard University (research associate, statistics)
- Dr. Robin Gregory, Decision Research (research associate, risk communication)
- Dr. Reto Rupf, Zurich University of Applied Sciences (research associate, tourism)

## 2 2020/21 Highlights

### 2.1 Research Projects

Over the last 12 months, the research efforts of SARP were focused on eleven main projects that can be grouped into four overarching themes.

#### 2.1.1 Decision-Making and Risk in Mechanized Skiing

- **Small-scale terrain choices in mechanized backcountry skiing operations (John Sykes)**  
Over the last 12 months, John has continued his work on adjusting the Swiss probable release area model, developed by Yves Bühler, to Canadian conditions. His main focus has been on applying the model to forested terrain. To address this challenge, John collaborated with Roger Atkins and Mike Welch from CMH Galena, who provided information about probable release areas in forested terrain at Galena based on their long-term experience in the terrain. Due to the somewhat qualitative nature of this information, John had to develop a new approach for using this information to tune the parameters of the probable release area model and assess its performance. John is currently in the process of drafting a manuscript about this work for submission to a peer-reviewed journal. The results of this research provide the foundation for meaningfully examining the GPS tracks that the SARP team have been collecting over the last few years.

- **Overview of Fatal Avalanche Accidents in the Mechanized Skiing in Canada (1970-2020) (Rosie Langford)**

Building on the research of Matthias Walcher, who examined the risk in mechanized skiing, Rosie Langford put together a research report that compiles all available information on fatal avalanche accidents in the Canadian mechanized skiing industry and summarizes patterns and trends. The report can be downloaded from the SARP website at [https://avalancheresearch.ca/pubs/2020\\_mechavfatalities/](https://avalancheresearch.ca/pubs/2020_mechavfatalities/).

### 2.1.2 Avalanche Hazard Modelling in Support of Operational Avalanche Forecasting

- **Operationalizing of snowpack modelling (Simon Horton)**

Over the last 12 months, Simon Horton continued work on snowpack modelling in support of operational avalanche forecasting. While the first two years of Simon's work at SARP were funded through the NSERC Industrial Research Chair, he is currently supported by a MITACS Elevate Post-Doctoral Fellowship in collaboration with Avalanche Canada. Simon's main focus over the last year were:

- Implementing the SNOWPACK modelling functionality on the Avalanche Canada cloud computing infrastructure;
- Developing a snowpack modelling dashboard for avalanche forecasters and practitioners (<https://avid-dx.avalanche.ca/clusters>); and
- Developing a meaningful approach for examining the quality of the precipitation input to the snowpack simulations using a variety of source of precipitation information.

- **Snowpack modelling in support of operational decision-making (Florian Herla)**

The long-term objective of Florian's project is to make snowpack modelling more useful for operational decision-making by: a) developing an approach that allows practitioners to correct snowpack models based on operational observations; and b) integrating the ideas of the conceptual model of avalanche hazard into the model chain. Over the last 12 months Florian got his first research paper published. It describes an algorithm for assessing the similarity of snow profiles. This algorithm represents the foundation for automatically aggregating and clustering simulated snow profiles as well as comparing them with observed profiles. In addition, Florian passed his comprehensive exam and is defending his PhD research proposal on April 26. Despite the fact that Florian has been stuck in Austria since the start of COVID-19, we were able to collect a meaningful research dataset over the 2020/21 winter for him by collaborating with the Avalanche Canada South Rockies field team, Fernie Alpine Resort, and Island Lake Lodge. This puts him in a good position to work on his next project, which focuses on automatically producing meaningful summary profiles. In addition to his research successes, Florian also passed his full mountain guiding exam this winter.

- **Designing for ambiguity (Stan Nowak)**

Stan continued his research on understanding avalanche forecasting practices to better inform the design of data visualizations and recording methods for avalanche hazard assessments. While he has developed various data visualizations as a consultant for the

AvID project of Avalanche Canada (weather observations, avalanche observations, MIN reports), his PhD research focuses on how avalanche forecasters can better document and share their judgments and reasoning process. The goal of this research is to improve efficiencies and consistency by making it easier for forecasters to share the less tangible metadata of their assessment process. Stan has developed various prototypes for the recording of this information based on interviews and is currently conducting a diary study with a select number of forecasters to examine the usefulness of the proposed tools.

- **Considerations for adding and eliminating avalanche problems (Heather Hordowick)**  
Following up on recent research showing that there can be considerable variability in avalanche forecasters' assessment of avalanche hazard, Heather's research is taking a qualitative approach to better understand how public avalanche forecasters add, transition and remove avalanche problems in public avalanche bulletins. In total, Heather conducted 22 long semi-structured interviews with forecasters from four different agencies (Avalanche Canada, Banff NP, Glacier NP, and Kananaskis Country). While half of the interviews focused on adding and removing storm/wind slab problems, the other half centered on the considerations for assessing persistent and deep persistent slab avalanche problems. For each of these interviews, Heather constructed a so-called concept map that documents the forecaster's process and considerations. Heather is now in the process of synthesizing this information into an overall picture of the similarities and differences in the existing practices. As soon as we have something meaningful to share, we will follow up with group sessions with the various forecasting teams. The outcome of this research will help forecasters have informed conversations on how to address existing forecast inconsistencies, and it will help researchers to better understand the processes behind the avalanche bulletin dataset.

### 2.1.3 [Avalanche Terrain Mapping](#)

- **Automated Avalanche Terrain Mapping (John Sykes, Rosie Langford)**  
In addition to his research on the application of probable release area models at CMH Galena, John has also been collaborating with researchers from Norway and Montana State University as well as Grant Statham, Cam Campbell, Mark Bender and Rosie Langford to improve a GIS algorithm for automatically mapping avalanche terrain according to the Avalanche Terrain Exposure Scale (ATES). The main contributions of the Canadian team are: a) establishing a process for developing consensus ATES maps that can be used to examine biases in the mapping of individual mappers; and b) developing a process for fine-tuning the parameters of the autoATES algorithm based on the consensus maps and the available GIS data. These two advances represent significant milestones towards reliably mapping large areas of mountainous terrain with autoATES. John is currently drafting two manuscripts about this work for publication in academic journals.

#### 2.1.4 Public Avalanche Risk Communication

- **Evaluating alternative information presentations and the effect of interactivity to avalanche risk communication (Katie Fisher)**

In the spring of 2020, Katie Fisher conducted a large-scale online survey with a route ranking task to examine three main research questions: a) How does the presentation of the avalanche problem aspect and elevation information affects bulletin users' ability to use this information; b) How do different forms of interactive feedback affect participants' performance in the survey; and c) Who is paying attention to the travel advice statements and can they be made more useful. Over the last 12 months, Katie has analyzed the dataset in detail, and she is currently preparing three manuscripts for submission to a peer-reviewed academic journal. The results of this research provide tangible guidance on how to improve the effectiveness of avalanche bulletin websites.

- **Perception and use of the avalanche danger scale (Abby Morgan)**

Using survey and interview data collected by Henry Finn and Anne St Clair in the spring of 2019, Abby is examining all questions that relate to the danger scale to better understand its strengths and weaknesses as a risk communication tool. Abby's main focus lies on examining how avalanche bulletin users perceive and use the danger scale in their trip planning process. The results of her research will help to better understand avalanche bulletin users and will provide important information for future adjustments to the danger scale.

- **Role of social media in avalanche risk management decision among recreationists (Amélie Goulet-Boucher)**

While avalanche bulletins were traditionally the primary source of avalanche safety information for recreationists, the rise of social media has completely changed the information landscape in the backcountry community. The purpose of Amélie's research is to better understand in what way social media plays a role in avalanche risk management decisions and for what reasons. To examine this research question, Amélie conducted 26 semi-structured interviews with a wide variety of backcountry recreationists over the 2020/21 winter. She is now analyzing the data to identify typical ways social media platforms are used by recreationists (both seeking and posting of information), to better understand what types of information needs social media covers that the bulletin currently does not, and to understand what the potential pitfalls of social media use are. The results of this research will help avalanche warning services use social media more efficiently and potentially adjust their products to better serve the community. In addition, the results will help avalanche safety educators to highlight the benefits and challenges of social media in their courses.

- **Development of a research panel of bulletin users interested in avalanche safety research for Euregio avalanche warning services (Pascal Haegeli)**

Last fall, the SARP team was approached by the Tyrolean and Swiss avalanche warning services to conduct an avalanche bulletin user study to inform future product development. To address this research need, we proposed a long-term user

engagement strategy and the development of a research panel with recreationists and avalanche safety decision-makers interested in participating in avalanche safety research. To start this research, we developed a relatively short, multilingual sign-up survey (<https://euregio.avalancheresearch.ca/>) to recruit as many interested participants as possible before the end of the winter. The initiative was launched on March 5, and by April 18, we had collected more than 2,000 email addresses. We are currently in the process of setting up the same sign-up survey for Switzerland.

## 2.2 Data Collection and Infrastructure

Despite COVID-19, we continued with the collection of research data and the development of the necessary infrastructure as much as possible. However, there have been several changes from previous years.

- **Collection of GPS tracks of professional terrain choices**

Due to the impact of COVID-19 on the mechanized skiing industry, we have paused the collection of GPS tracks during the 2020/21 winters. While most of the operations that collaborated with us in the past did not operate this winter, we did not want to burden the operators that did try to pull off a season with the extra work required for GPS tracking.

As of right now, our dataset consists of 10,533 tracked guide days including slightly more than 70,500 ski runs under a wide variety of conditions. This is a substantial dataset for research in the near future. Collaborating operations can access their own tracks using an online viewer.

- **Roaming snow profiles in SE British Columbia**

To facilitate Florian Herla's next research objective, we collaborated with the Avalanche Canada South Rockies field team, Fernie Alpine Resort, and Island Lake Lodge to collect a dataset of roaming snow profiles, weekly study plot profiles, and synthesized human "white board" profiles. This dataset provides the foundation for developing a meaningful approach for automatically summarizing snow profile information.

- **Operational snowpack modelling**

The operational snowpack modelling infrastructure has been transferred from SFU research computing infrastructure to Avalanche Canada. This move is in support of Avalanche Canada's long-term vision for the integration of snowpack modelling in operational avalanche forecasting. We will continue to use the infrastructure at SFU for research and development purposes.

## 2.3 Securing Additional Research Funding

Our fundraising efforts from Canadian academic sources primarily focused on securing funding for our new master students and leveraging industry contributions that were not previously matched:

- MITACS Accelerate Fellowship for Amélie Goulet-Boucher with support from Avalanche Canada (\$40k, awarded on Oct. 2, 2020)

- MITACS Accelerate Internship for Abby Morgan with support from Avalanche Canada (\$15k, awarded on Aug. 8, 2020)
- MITACS Elevate Fellowship for Simon Horton with support from Avalanche Canada (\$60k, awarded Jul. 15, 2020)

Outside of the Canadian funding sources, the research team was approached by the **Tyrolean and Swiss Avalanche Warning Services** to conduct avalanche bulletin user research in Euregio (Tyrol, South Tyrol, and Trentino) and Switzerland. The two organizations have committed to support the research program with a total of \$87k (incl. \$17k SFU indirect research costs) until December 2023.

We were also approached by **Tordrillo Mountain Lodge** (<https://www.tordrillomountainlodge.com/>), an Alaskan heliski company interested in supporting graduate research in avalanche risk management. Our conversations in the fall focused on supporting a master student project with \$40k over two years, but we were unable to finalize the arrangement before the start of the 2020/21 winter season. We will pick this conversation up again once the season is over.

I am also a co-investigator on a **SAR-NIF proposal** that was submitted to the National Search and Rescue Secretariat in collaboration with Dr. Alexandre Langlois of the University of Sherbrooke and Drs. Fortin and Vionnet at Environment Canada. The main goal of the proposed project is to increase the quality of the Canadian Precipitation Analysis (CaPA) and the quantitative precipitation forecasts over mountain regions in winter by integrating InfoEx observations to the CaPA analysis. Since precipitation is one of the key sources of uncertainty in avalanche forecasting, improved precipitation analysis and forecasts will help improve our snowpack modelling efforts and the snowpack stability assessments and avalanche predictions of practitioners.

Finally, I am a co-investigator with Drs. Andréanne Doyon and Cliff Atleo (both SFU) on a \$30k research grant awarded from HeliCat Canada for the development of an **Indigenous Relations Strategic Engagement Plan**. This contribution from HCC was recently increased to \$60k with matching funds from the MITACS Accelerate program.

## 2.4 Outreach

### 2.4.1 Peer-reviewed Publications

We published a total of **seven academic peer-reviewed papers** over the last 12 months:

1. Haegeli, P., Shandro, B., and Mair, P. (2021). Using avalanche problems to examine the effect of large-scale atmosphere-ocean oscillations on avalanche hazard in western Canada. *The Cryosphere*, 15, 1567-1586, doi: 10.5194/tc-15-1567-2021.
2. Herla, F., Horton, S., Mair, P., and Haegeli, P. (2021). Snow profile alignment and similarity assessment for aggregating, clustering, and evaluating of snowpack model output for avalanche forecasting. *Geoscientific Model Development*. 14, 239-258, doi: 10.5194/gmd-14-239-2021

3. Pröbstl-Haider, U., Hunt, L.M., Rupf, R., and Haegeli, P. (2020). Choice experiments in outdoor recreation. *Journal of Outdoor Recreation and Tourism*, 32, 100321. doi: 10.1016/j.jort.2020.100321.
4. Haegeli, P., Rupf, R., and Karlen, B. (2020). Do avalanche airbags lead to riskier choices among backcountry and out-of-bounds skiers? *Journal of Outdoor Recreation and Tourism*, 32, 100270. doi: 10.1016/j.jort.2019.100270.
5. Haegeli, P., and Strong-Cvetich, L. (2020). Using discrete choice experiments to examine the stepwise nature of avalanche risk management decisions—An example from mountain snowmobiling. *Journal of Outdoor Recreation and Tourism*, 32, 100165. doi: 10.1016/j.jort.2018.01.007.
6. Horton, S., Towell, M., and Haegeli, P. (2020). Examining the operational use of avalanche problem with decision trees and model-generated weather and snowpack variables. *Natural Hazards and Earth System Science*, 20, 3551-3576. doi: 10.5194/nhess-20-3551-2020.
7. Horton, S., Nowak, S., and Haegeli, P. (2020). Enhancing the operational value of snowpack models with visualization design principles. *Natural Hazards and Earth System Science*, 20, 1557-1572. doi: 10.5194/nhess-20-1557-2020.

Several additional research articles are currently in preparation and close to submission.

In addition, we published the following report on our website:

1. Langford, R., and Haegeli, P. (2021). Overview of Fatal Avalanche Accidents in the Mechanized Skiing Industry in Canada (1970-2020). Report prepared for HeliCat Canada, p. 18. Available on the SARP website at [http://www.avalancheresearch.ca/pubs/2020\\_mechavfatalities/](http://www.avalancheresearch.ca/pubs/2020_mechavfatalities/)

#### 2.4.2 Publications in Community Journals

Over the last 12 months, my research team and I published **2 articles in community journals**.

1. Haegeli, P. and SARP Research Team (2021). How is avalanche problem information used? *The Avalanche Journal*, 126, 36-38.
2. 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.

Both of these articles were also published in the *Avalanche Review (TAR)* of the American Avalanche Association.

#### 2.4.3 Software

Over the last 12 months, my research team and I also published the following two R packages to share our methods with the broader research community.

1. Herla, F., Haegeli, P., and Horton, S. (2020). sarp.snowprofile.alignment: Snow Profile Alignment, Aggregation, and Clustering. Version 1.0.2 published on CRAN on December 3, 2020. <https://cran.r-project.org/package=sarp.snowprofile.alignment>
2. Haegeli, P., Horton, S., and Herla, F. (2020). sarp.snowprofile: Snow Profile Analysis for Snowpack and Avalanche Research. Version 1.0.0 published in CRAN on July 25, 2020. <https://cran.r-project.org/package=sarp.snowprofile>

#### 2.4.4 Presentations at Academic Conferences

COVID-19 unfortunately resulted in the cancellation of the in-person 2020 ISSW in Fernie, which prevented us from sharing all of our recent accomplishments with the international avalanche safety research community. However, we did give an invited oral presentation during the shorter online version of the conference. Many academic conferences going online also allowed us to present at conferences that we would normally not be able to attend (e.g., fall meeting of American Geophysical Union). In total, my research team and I gave **12 presentations at three academic conferences over the last 12 months.**

1. Haegeli, P., Morgan, A., Finn, H., St Clair, A., Klassen, K., and Gregory, R. (2020). Demystifying the murky mid-range of hazard and risk scales. Lightning talk presentation at the virtual 2020 Annual Meeting of the Society for Risk Analysis, December 13-17, 2020.
2. Fisher, K., and Haegeli, P. (2020). How information presentation and interactivity affect the interpretability of spatial hazard information – Lessons from a study in avalanche safety. Lightning talk presentation at the virtual 2020 Annual Meeting of the Society for Risk Analysis, December 13-17, 2020.
3. Horton, S., and Haegeli, P. (2020). Evaluating snowfall patterns pertinent to regional-scale avalanche hazard with data from stations, field reports, and models. Poster presentation at the virtual 2020 AGU Fall Meeting, December 1-17, 2020.
4. Sykes, J., Haegeli, P., and Bühler, Y. (2020). Avalanche Hazard Indication Mapping for Forested Terrain in the Selkirk Mountains, British Columbia, Canada. Poster presentation at the virtual 2020 AGU Fall Meeting, December 1-17, 2020.
5. Haegeli, P., Shandro, B., and Mair, P. (2020). Using avalanche problems to examine the effect of large-scale atmosphere-ocean oscillations on avalanche hazard in western Canada. Oral presentation at the virtual 2020 AGU Fall Meeting, December 1-17, 2020.
6. Herla, F., Horton, S., Mair, P., and Haegeli, P. (2020). Snow profile alignment and similarity assessment for aggregating, clustering, and evaluating of snowpack model output for avalanche forecasting. Oral presentation at the virtual 2020 AGU Fall Meeting, December 1-17, 2020.
7. Nowak, S., Bartram, L., and Haegeli, P. (2020). Designing for Ambiguity: Visual Analytics in Avalanche Forecasting. Oral presentation at virtual IEEE VIS 2020, October 25-30.

Peer-reviewed paper included in the IEEE VIS Short Paper Proceedings [available online at <https://arxiv.org/abs/2009.02800>]

8. Horton, S., Müller, K, Haegeli, P., and Engeset, R., (2020). How close are we to automated avalanche forecasting? Lessons from testing machine learning methods in Norway and Canada. Poster presentation at the 2020 Virtual Snow Science Workshop, October 5 and 6, 2020.
9. Horton, S., Herla, F., and Haegeli, P. (2020). Developments for verifying (and improving) snowpack simulations at the regional scale. Poster presentation at the 2020 Virtual Snow Science Workshop, October 5 and 6, 2020.
10. Horton, S., Nowak, S., and Haegeli, P. (2020). A new set of color scales to visualize snow profiles more effectively. Poster presentation at the 2020 Virtual Snow Science Workshop, October 5 and 6, 2020.
11. Horton, S., Herla, F., and Haegeli, P. (2020). An R package for snow profile analysis and visualization. Poster presentation at the 2020 Virtual Snow Science Workshop, October 5 and 6, 2020.
12. Haegeli, P., Fisher, K., Morgan, A., Finn, H., and St. Clair, A. (2020). How to make avalanche bulletins more effective? – Lessons from studying user practices Invited oral presentation at the 2020 Virtual Snow Science Workshop, October 5 and 6, 2020.

#### 2.4.5 Technology Transfer

While COVID-19 has seriously hampered our ability to connect with industry partners and contribute to staff training sessions, core SARP members gave **9 online technology transfer presentations** over the last 12 months. In addition to presentations in Canada, we also presented to avalanche professionals in the United States and Europe. In total, an estimated 925 avalanche professionals were reached with these presentations (1,535 if each presentation is counted individually).

1. Haegeli, P. (2021). Wie können uns Wintersportler/innen helfen, die Effektivität der Lawinenvorhersageberichte zu verbessern? Oral presentation at the monthly online meeting of the Austrian Avalanche Association (OeGSL Semmelnar), February 1, 2021. (size of audience: approx. 50)
2. Haegeli, P. (2021). Avalanche Research @ Simon Fraser University. Online presentation during monthly meeting of Coquitlam SAR Team. January 26, 2021. (size of audience: approx. 25)
3. Haegeli, P. and Shandro, B. (2021). Using avalanche problems to examine the effect of large-scale atmosphere-ocean oscillations on avalanche hazard in western Canada. Oral presentation at the monthly online seminars of the American Avalanche Association. January 18, 2021. [recording available online at <https://theavalanchereview.org/avalanches-and-climate-change/>] (size of audience: approx. 150)

4. Haegeli, P. (2020). Avalanche Airbags – What we know from research. Oral presentation at the monthly online seminars of the American Avalanche Association. December 10, 2020. [recording available online at <https://theavalanchereview.org/avalanche-safety-technologies/>] (size of audience: approx. 250)
5. Goulet-Boucher, A., and Haegeli, P. (2020). Les sacs-à-dos d’avalanche “airbag”: la solution magic? Séminaire Avalanche Québec 2020 – Édition en ligne, December 9, 2020 (size of audience: approx. 80).
6. Langford, R., and Haegeli, P. (2020). Fatalities in mechanized guiding operations in Canada: 1974-2020. Monthly call of HeliCat Canada Members, November 9, 2020 (size of audience: approx. 30).
7. Fisher, K., and Haegeli, P. (2020). Studying the effects of avalanche safety information, interactivity, and feedback on route choice selection. Virtual Spring Meeting of Canadian Avalanche Association. May 12, 2020 (size of audience: 350).
8. Herla, F., Horton, S., and Haegeli, P. (2020). Computer assistance for avalanche forecasting. Virtual Spring Meeting of Canadian Avalanche Association. May 12, 2020 (size of audience: 350).
9. Sykes, J., and Haegeli, P. (2020). Assessing avalanche terrain exposure using avalanche hazard indicator maps and GPS tracks. Virtual Spring Meeting of Canadian Avalanche Association. May 12, 2020 (size of audience: 350).

#### 2.4.6 Public Outreach

Similarly, COVID-19 made connecting with the public more challenging this year, but the online format of many public avalanche awareness events made it possible for us to attend with the need to travel. Over the last twelve months, core SARP members **participated in five public avalanche awareness events** reaching an estimated 850 recreationists (1,200 if each presentation is counted individually).

1. Haegeli, P., Fisher, K., and Morgan, A. (2020). Learning about the readers of our backcountry avalanche forecasts. Invited presentation at the virtual 2020 Bend Snow and Avalanche Workshop in Bend, OR, November 14, 2020 (size of audience: approx. 100).
2. Haegeli, P., Fisher, K., and Morgan, A. (2020). Learning about the readers of our backcountry avalanche forecasts. Invited presentation at the virtual 2020 North Rockies Snow and Avalanche Workshop in Whitefish, MT, November 13, 2020 (size of audience: approx. 100).
3. Haegeli, P., Fisher, K., and Morgan, A. (2020). Everything you ever wanted to know about bulletin users but were afraid to ask. Invited presentation at the virtual 2020 Northwest Snow and Avalanche Workshop in Seattle, WA on October 20, 2020 (size of audience: approx. 300).

4. Haegeli, P., Fisher, K., and Morgan, A. (2020). Learning about the readers of our backcountry avalanche forecasts. Invited presentation at the virtual 2020 Colorado Snow and Avalanche Workshop in Boulder, CO, October 14-16, 2020 (size of audience: approx. 350).
5. Horton, S. (2020). Snow Modeling 101 and Applications for Practitioners. Invited presentation at the virtual 2020 Colorado Snow and Avalanche Workshop in Boulder, CO, October 14-16, 2020 (size of audience: approx. 350).

SARP research also attracted media attention. There have been several online articles with the most prominent mention being an article published in the German Magazine for Sport Medicine:

- Hutterer, Ch. (2020). Prävention von Lawinenunfällen [German]. Deutsche Zeitschrift für Sportmedizin. [available online at <https://www.zeitschrift-sportmedizin.de/praevention-von-lawinenunfaellen/>].

## 2.5 Award and Recognitions

In the last twelve months, my research team and I received the following recognitions:

- Anne St. Clair received the SFU Dean of Graduate Studies Convocation Medal for her Master's thesis research of avalanche bulletin user types.
- Anne St. Clair was also awarded the SFU Dean of Graduate Studies Entrance Scholarship for her PhD (\$21,000 per annum for 4 years).

Both of these awards are extremely prestigious, and I am very proud that Anne's work was recognized like this at the university level.

## 2.6 University Teaching

I did not teach my course on **avalanche risk management** (REM427/627) this year as it is only scheduled every two years.

## 2.7 Student Training

Since my research program does not have a field program, I am using the following approaches to train my students in addition to the supervision of their personal research projects:

- Organizing visits to collaborating operations; and
- Weekly group meetings where we discuss current avalanche conditions (if applicable only) and research papers on special topics.

Suggestions for how to better train students for industry needs are welcome.

## 2.8 Other Relevant Activities

### 2.8.1 Justice, Equity, Diversity and Inclusion (JEDI)

In response to today's growing conversation and movement towards a more just, equitable, diverse and inclusive society, my team and I spent considerable time this winter reflecting on where we are situated in this space and how we can promote change in a meaningful way. The

result of this effort is a positionality statement on JEDI that described our vision for contributing to sustainable and permanent change. You can find our statement with our action items on our website at <https://www.avalancheresearch.ca/jedi/>.

### 2.8.2 Centre for Tourism Policy and Research

One of my roles at SFU is the Directorship of SFU's **Centre for Tourism Policy and Research (CTPR)**, a research centre that was established in the late 1980s to support BC's tourism industry with policy relevant research. I believe that the CTPR offers the avalanche and backcountry tourism community an exciting opportunity for accessing high-quality interdisciplinary research expertise in relevant topics including Indigenous relations, reconciliation and Indigenous capacity building, climate change impacts and decarbonization, sustainability initiatives and economic development in rural communities. A good example of these possibilities is Helicat Canada's **Indigenous Relations Strategic Engagement Plan** project where I was able to connect Helicat with Dr. Andréanne Doyon and Cliff Atleo from our faculty.

Please let me know if you have any needs in these areas, and I am happy to connect you to suitable researchers at SFU.

### 2.8.3 CMH Terrain Knowledge Capture

In the fall of 2020, Canadian Mountain Holidays contracted SARP to use the ski run characterization survey we developed in 2019 to systematically capture the terrain knowledge of their guiding teams. This service is provided for a minimal fee to cover the cost associated with setting up and maintaining a dedicated survey instance for CMH.

## 2.9 Challenges

### 2.9.1 COVID-19

Like everybody else, our research group has been affected by COVID-19. All of our research activities, meetings and presentations have been conducted online for the entire year. My research team is currently spread out between Anchorage, Victoria, and Innsbruck, Austria, and only one team member and I are currently in Vancouver. However, in comparison to other segments of the avalanche safety industry, the impact of COVID-19 on our research group has been relatively minor. The transition to working online was fairly smooth, and research activities have so far continued as planned. Nobody lost any data collection opportunities or needed to redesign their research projects. However, I find designing of new research projects and maintaining regular contact with industry partners more challenging under the current circumstances.

The current plan of SFU is to return to in-person research and teaching at the start of the next academic year in September. However, students have adjusted to the online environment and re-established their homes away from Vancouver over the last year, and how exactly we will transition back into the post-pandemic research arrangement is currently up for discussion.

### 2.9.2 Other Challenges

In my opinion, the operational challenges for my program are:

- Maintaining a continuous and meaningful connection with supporting organizations and practitioners to ensure the research we work on is meaningful to the community; and
- Providing my students with the training they need to allow them to start a promising career in the avalanche community.

Any guidance on these challenges is welcome.

## 3 Outlook for Next 12 Months

### 3.1 Context

We are slowly coming towards the end of the existing funding commitments for the SARP research program. While the existing commitments from the Canadian industry partners are coming to an end on August 31, 2022, I have recently received approval from NSERC for a one-year non-cost extension of the Industrial Research Chair program. The reasons for this extension are cost savings I have made so far, slight delays due to COVID, and small changes in the research directions. This means that we can continue with the existing research projects for another year at no extra cost. When my term as a research chair comes to an end on August 31, 2022, my teaching load at the university will double (3 courses every year instead of every two years).

### 3.2 Personnel

At this point, we will have one new team member joining the SARP team in the fall of 2021:

- Anneliese Neweduk (Masters student; REM project stream)

### 3.3 Priorities

The main focus for the next twelve months is to take advantage of the momentum we have built and make substantial progress on the Industrial Research Chair Program and the public avalanche risk communication research. We have several applied research publications in the pipeline that need to be published in a timely fashion. In addition, I would like to start the conversation with industry partners about possible research directions past the current funding commitments and the end of the Industrial Research Chair.

#### 3.3.1 Research

- Properly transition Simon and the snowpack modelling infrastructure to Avalanche Canada and establish the research relationship.
- Continue existing research projects with John, Florian, and Stan.
- Publish ATES research with John.
- Develop full PhD research proposals with Anne.
- Finish and publish the research projects with Katie, Abby, Amelie and Heather.
- Develop a MRM thesis project with Rosie and possibly get a head start with Anneliese.
- Finalize the publications of Anne and Henry's research in peer-reviewed journals.
- Turn Taylor and Brendan theses into research articles and submit them to peer-reviewed journals.

- Write a position paper on how to more effectively conduct social science research in support of public avalanche safety.
- Conduct the first avalanche bulletin user survey for Euregio and Swiss Avalanche Warning Service.
- Properly establish a North American research panel for social science studies.

### 3.3.2 Funding

- Start discussing research priorities and funding possibilities with Canadian industry partners for after the end of the existing commitments (end date: August 2022) and the NSERC Industrial Research Chair (extended end date: August 2023).

### 3.3.3 Outreach

- Attend the 2021 Annual Meeting of the Society for Risk Analysis (December 2021).
- Continue to build a research network outside of traditional avalanche research fields within SFU (e.g., big data, visualization) and beyond (e.g., risk communication).
- Strengthen public outreach with brief research videos on social media, practical resources on the website, presentations, and articles published in the Avalanche Journal and presentations.
- Strengthen connection with operators and avalanche professionals by visiting them (once possible) and connecting them with students more frequently.

### 3.3.4 Student Training

- Once appropriate again, develop a better plan for giving students the opportunity to go into the field and connect with collaborating operations and avalanche professionals in a meaningful way.

### 3.3.5 Anticipated Challenges

- Over the last years, I highlighted that the program has grown tremendously since it started in the fall of 2015, and that I was concerned about reaching the limit of my capacity. I still have concerns about this, and I am hoping to use this year to catch up and work on the backlog of publications before further growing the research program.

## 4 Questions

If you have any question about SARP's research activities, please contact me anytime either by email ([pascal\\_haegeli@sfu.ca](mailto:pascal_haegeli@sfu.ca)) or phone (778-782-3579 or 604-773-0854).