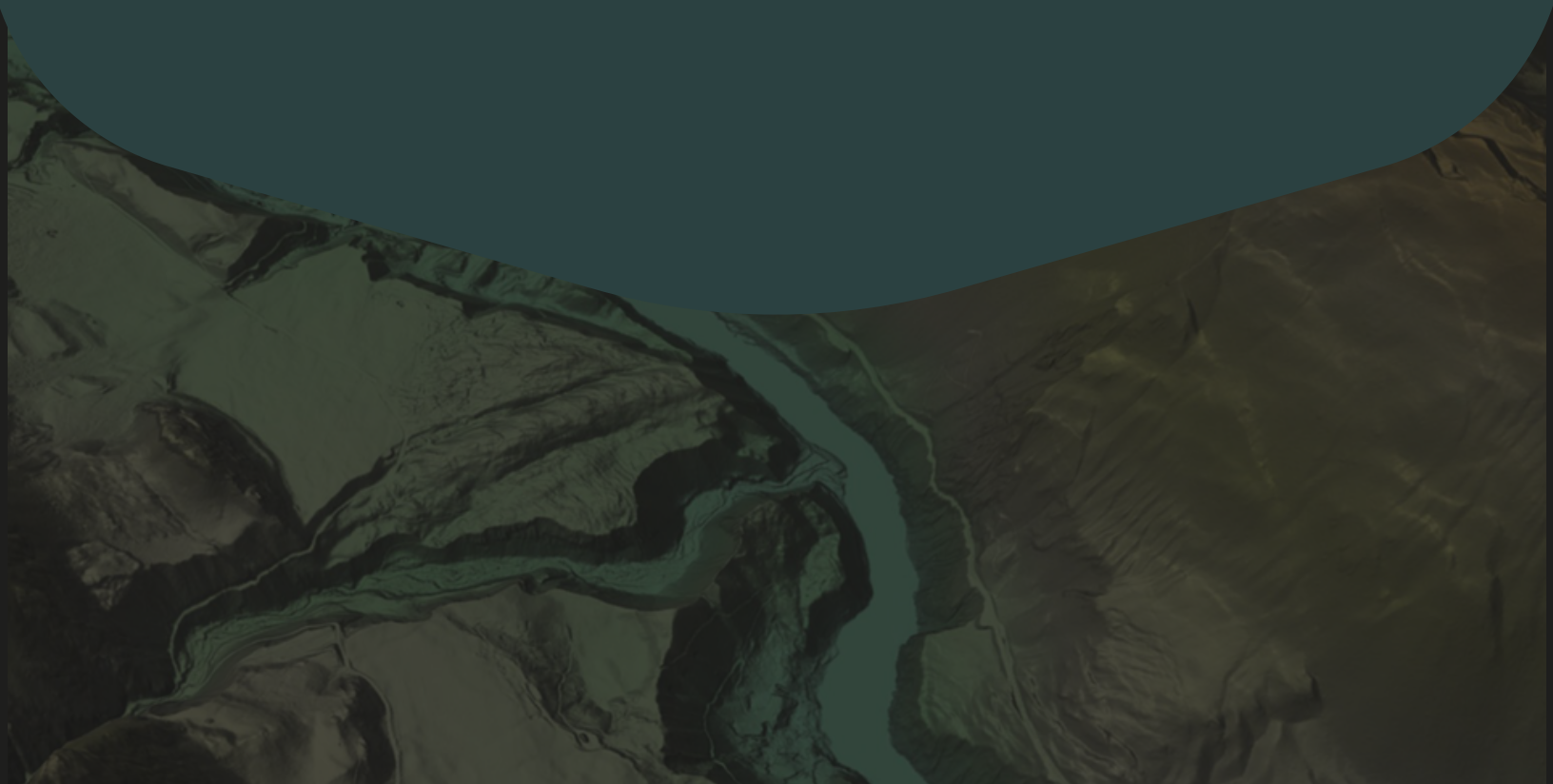


[FRASERBASIN.BC.CA/FRASERSLIDES.HTML](https://FRASERBASIN.BC.CA/FRASERSLIDES.HTML)

FRASER LANDSLIDES  
RESEARCH PROJECT  
COMMUNITY ENGAGEMENT SESSION

05/10/2022



## PROJECT BACKGROUND

Late in 2018, a large amount of material broke away from the cliffs above the Fraser River, southwest of Clinton, BC, in a remote section of the river. The Big Bar Slide, as it was called, created a blockage in the river that significantly and negatively affected migrating salmon due to adverse water flows, and cost millions of dollars in ongoing mitigation costs.

The impacts of another slide similar to the Big Bar Slide could be catastrophic. Migrating Fraser River salmon populations are at record low numbers, and another significant slide blocking migration could spell disaster for these already stressed and vulnerable salmon populations. However, the likelihood of a similar slide occurring again is unknown.

The project, "Landslide impact on flow dynamics, fish migration and genetics of Fraser River salmon" is a collaboration between academia, First Nations, government (DFO), and NGOs that aims to understand how past and present slides in the Fraser River Canyon have affected river flows and subsequent migrating salmon populations. Analysis of past slide dynamics will be used to develop a predictive model of potential future slide activity, and may inform potential future slide response. Indigenous Knowledge holders will be engaged to assess the understanding of past slide events and their impacts on salmon migration in Fraser Canyon First Nations communities.

This three-year project will ultimately aim to assess the potential and risk of another slide blocking the Fraser River, and the impact of such a slide on migrating salmon.

## YEAR 1 WORKSHOP

The Fraser Landslides Research Project held their 'Year 1 Workshop' on May 10th, 2022 at T'it'qet First Nation in Lillooet, British Columbia. The session was held both in-person and online, where discussion focused on how information and knowledge can be shared to support and build relationships between First Nations and researchers.

The workshop was facilitated by Kim Menounos (Fraser Basin Council) with support from Greg Witzky (First Nations liaison), Jeremy Venditti (Simon Fraser University) and Tasha Peterson (FBC).

## YEAR 1 WORKSHOP CONT.

The **Year 1 Workshop objectives** were:

- To build working relationships between the Fraser Landslides research team and Fraser River First Nations
- To create an opportunity for communication and understanding of Indigenous Knowledge, empirical science, and where intersections can enhance outcomes
- To share project updates and listen to broad perspectives

A full list of workshop attendees can be found in Appendix A, along with the workshop agenda in Appendix B.



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## MEETING NOTES

Harold Pelegrin, Ti'q'et First Nation Elder, shared a prayer for the success of the session and welcomed participants to the territory.

## RESEARCH PROJECT OVERVIEW

Jeremy Venditti, Simon Fraser University

- The Fraser Landslides research project studies landslide impacts to flow dynamics, fish migration and genetics of Fraser River salmon
- It is a science partnership that consists of university-based researchers collaborating with First Nations, NGOs and Fisheries and Oceans Canada (DFO) scientists
- The project is funded by the British Columbia Salmon Restoration Innovation Fund (Province of BC and DFO), and Hakai Institute
- The project will run August 2021 to March 2024
- Partners include: Durham University, Fisheries and Oceans Canada, Fraser Basin Council, Fraser Salmon Management Council, Hakai Institute, Simon Fraser University, University of Massachusetts, University of Northern British Columbia and the University of Victoria
- The project aims to answer three questions:
  - Past: How have landslides impacted the Fraser River and salmon?
  - Present: How is the Big Bar landslide affecting channel morphology and flow, salmon migration, and salmon genetics?
  - Future: Where will the next big landslide occur, and how will it impact salmon?
- Past impacts are being examined using LiDAR mapping to inventory slides, cosmogenic dating to develop a chronology of past slides and historical information, including Traditional Knowledge
- Monitoring stations have been/will be set up in the Fraser Canyon to examine present impacts: Big Bar, Hell's Gate, Black Canyon and Scuzzy Rapid
- The research team will identify and map locations that may be susceptible to future landslides using on-the-river mapping, LiDAR and remote sensing technology.
- The team is seeking more opportunities to collaborate with First Nations and communicate results

# IDENTIFYING PAST LANDSLIDES IN ELEVATION DATA

Aaron Steelquist, Simon Fraser University

- Landslides leave fingerprints on the landscape
- Main scarp and landslide debris are key features that can show where landslides have happened
- LiDAR data allows us to see this better because it removes the trees that may be in the way
- Using LiDAR technology, the Hakai Institute has collected elevation data from Yale to Soda Creek between 2016 and 2020
- This data is about 10 kilometers wide, 5 kilometers on either side of the Fraser River
- Approximately ~300 potential landslide features were identified, ranging from large earthflow complexes to small scarps in scree slopes
- The Texas Creek landslide likely would have blocked the river for a number of years
- Showed imagery of the Big Bar Slide geomorphic change detection between 2010-2019 – slide creating a barrier for fish migration
- Looking at where these past slides have occurred to determine where slides could occur in the future
- Hakai Institute created a 3D model at Big Bar: <https://sketchfab.com/3d-models/big-bar-landslide-march-2022-06fa84a7a36e4a529ef5c1dd218caaa5>

## Discussion:

Q: Why was the 5km range selected?

ANS: Due to topography and logistical safety considerations at the time. With different equipment, we will not be limited to that range in the future.

Q: Have you considered the Thompson River – has it been part of discussions? Future project potential?

ANS: The Province provides free LiDAR in some areas for initial looks, and there is some coverage on the Thompson:

<https://governmentofbc.maps.arcgis.com/apps/MapSeries/index.html?appid=d06b37979b0c4709b7fcf2a1ed458e03>

Q: How would you characterize the ~300 potential slide locations?

ANS: Some are small little slide features in the loose sediment left by glaciers while others are drainage basins that look like they may have originally been landslide scars. There is quite a wide variety and some are not relevant for this topic at hand.



## IDENTIFYING PAST LANDSLIDES IN ELEVATION DATA

Aaron Steelquist, Simon Fraser University

### Discussion Cont.:

Q: Has Hell's Gate been compared to Big Bar? One man made vs. natural event.

ANS: Not directly, there is much less information about Hell's Gate than Big Bar, however both were rock fall events that happened in already constricted portions of the river. They are similar in that sense.

Q: Was Big Bar considered or identified as a risk? Would it have been?

ANS: Jeremy stated that they were not specifically looking for landslide-susceptible parts of the Fraser on his float, so it was not identified as a risk. However, it would be considered a high-risk area within our assessment completed in April/May 2022. The sites we identified as potential hazards have similar characteristics to Big Bar.

Q: How will the wildfires change the frequency of landslides occurring?

ANS: Wildfires are likely to result in a higher frequency of debris flow events, which deliver large amounts of sediment to the channels via tributaries. This is similar to the many slides we saw in November 2021. However, fires are not believed to have a large impact on the likelihood of the slide type (rock slide/rock fall) that occurred at Big Bar.



# QUANTIFYING FLOW AND BED ELEVATION IN THE FRASER CANYON

Matteo Saletti, Simon Fraser University

- Looking to answer two key questions:
  - 1. Which segments of the canyon are more likely to be an obstacle for fish passage?
  - 2. To what extent is fish passage determined by the flow conditions (flow velocity, discharge, turbulence), rather than other factors (such as species, size, migration timing)?
- Monitoring locations determined by flow in the specific sections of the Canyon
- Data collection includes bed elevation, surface velocity (drone or fixed camera), 3D velocity (+below the surface)
- Data is being used to create a 3D model of the Canyon and create velocity maps of the sections being monitored
- Velocity maps in different segments of the Canyon and for different flows will tell us which areas are the most critical for fish passage
- Comparative analysis using data from fish tagging, flow measurements and genetics will help us determine which factors are more critical for fish passage

## Discussion:

Q: Which is better, cameras vs. drones?

ANS: Drone flights are better because you can select multiple other variables; cameras can collect data over long periods of time (cannot fly drone all day).

# HOW DO LANDSLIDES AFFECT SALMON MIGRATION

Evan Byrne, Simon Fraser University

- Looking at what we can learn from the Big Bar landslide and response
  - Shared imagery of 2019 hydraulics
  - Response to determine if Salmon could make it back up the river
- Radiotracking of salmon – Big Bar Response and DFO (with provincial partners)
  - Approximately 1,500 salmon tagged in 2020
  - Showed salmon getting to slide location, but passage highly limited until late summer when discharge lower
  - After discharge dropped below passable threshold, many salmon required multiple attempts, some still failed to pass slide and moved down river
- Salmon movements raise questions about impact to swimming ability and migration behaviors
  - How long are the fish waiting to go through fish passage?
  - What areas are salmon waiting and trying to pass?
    - Do these areas change at different river flows?
  - Do limits in salmon swim speed endurance limit successful passage?
- Traditional tracking is not adequate to answer questions
- Will use fine-scale tracking techniques instead, which give information on location, acceleration and depth
  - Able to identify when and where salmon are swimming at different speeds
  - Can estimate how long it takes to recover from fast swimming activity and total energy used to pass slide location

## Discussion:

Q: How many First Nations were involved in the monitoring; important to know whose land it is.  
ANS: partnerships are widespread; can be difficult to determine whose land - work is still being done; DFO has additional information on this.

Q: Are the fish making it back and are they surviving/reproducing?  
ANS: Last year we saw good numbers of fish making it back; more data is needed.

COMMENT: Fisheries were shut down along the Fraser; some members packing fish across channels to help. Fish are the lifeblood of their people.



## HOW DID BIG BAR EFFECT THE GENETICS OF PACIFIC SALMON

Gregory Owens, University of Victoria

- Salmon diversity is due to genetics; there are many different species and there is diversity within species
- Trying to find out if genetics plays a role in the ability of salmon to pass the Big Bar landslide
  - Gave visual examples on what it would look like for the result to be yes or no
- Why do genetics matter? Possibly play a role in endurance swimming ability, run timing, etc.
- DFO put radio tags on Chinook and Sockeye Salmon at Lillooet and then tracked whether they made it over Big Bar naturally or not
- Fin clips were taken from the tracked salmon and DNA was extracted. Will be sequencing the genomes of all the fish to see if a specific gene is associated with success
- Will also be looking at if populations have changed due to the Big Bar slide blockage by looking at genomes of salmon populations over multiple years
- Reduced diversity can make populations more sensitive to future problems

### Discussion:

Q: How has the genetics been impacted by a disaster like Mt. Polly?

ANS: I'm not sure if anyone is working on the genetics of the salmon that were impacted by the Mt. Polly disaster, but I know a big focus is how much the toxic materials (especially copper) have accumulated in the species that the salmon will be eating in that ecosystem. There is a decent amount of research on the impacts of heavy metal pollutants on salmon navigation (among other impacts), but I don't know of any genetic work being done on those populations.

Q: Was a genetic study done at Hells' Gate?

ANS: I don't think we know if there are genetic samples that we (or anyone) would be able to use because of how old the tissue samples and/or scales would be. We would have to discuss with PSC or DFO if they have available samples from that time frame - but even if they did, and we were able to find the funding to bring Hell's Gate samples into our research, I'm not sure if we'd be able to get good quality DNA from tissue/scales that old.

Q: Is the idea that the strong survive and those will then be less at risk for future slides?

ANS: Possibly. Generally, think that diversity of the species is best. For example, some salmon may be the best swimmers, but not the most disease resistant. It is better to have both types in the population

# HOW DID BIG BAR EFFECT THE GENETICS OF PACIFIC SALMON

Gregory Owens, University of Victoria

## Discussion Cont.:

Q: Are Early Stuart of the most concern?

ANS. Data us limited by the number that made it over that were tagged.

Q: Would you expect the Early Stuart to have a similar change to those you are looking at?

ANS: The population is starting at a different point and face a different landscape so the response could be different.

Comment: Fish farms are having an impact. Have noticed 10/12 fish have holes in their hearts. Need to look further into the impacts of farms.

Comment: Viruses or potential disease is definitely something to consider, but not part of this specific study.

Comment: Read a paper on the Fraser Fault near 10-mile slide. There is a slab of rock two miles long, 200 m thick that has the potential to slide into the Fraser.

Comment: The warmed waters from riparian logged streams weaken the female salmon enough to stop them from reaching the spawning grounds; pre-spawn mortality.



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## AFTERNOON SESSION - GROUP DISCUSSION

During the afternoon session participants entered into dialogue in groups of four-five people to discuss the following two questions.

### **1. Discuss up to ten things you are interested in or questions you may have.**

The following questions/interests were identified by the group. These questions will help inform further discussions and objectives for our next workshop.

#### Landslide Research & Response

- How will climate change affect slide frequency?
- How are we going to respond when another slide occurs?
- Is there an ability to determine how the slide occurs?
- How important are downstream, not high-risk areas?
- Interested in locating future slide sites.

#### Salmon Research

- How many landslides impact salmon?
- How much genetic material should be saved to help future impacts?
- What about the other fish species; how are they affected?
- Interested in monitoring fish after a slide.

#### First Nations Involvement & Traditional Knowledge

- How are First Nations involved and paid during this project?
- Interested in how traditional knowledge of the river can help better understand salmon history, and history of river blockages/landslides.

#### Project Information & Data Sharing

- Where is the data going to live and how can it be shared/distributed?
- How can we be involved/get regular updates/work with the team?

#### Additional Questions

- Is there anything we can do now (groundwork) to set ourselves up for success in the future?
- What activities occurred in these areas? Are there trails or artifacts in the areas?

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## AFTERNOON SESSION - GROUP DISCUSSION

### 2. What are some ways that we can work together?

The following suggestions and considerations recorded from the session have been grouped into common themes.

#### Information & Data Sharing

- Email sharing/updates for all participants
  - SFU already writes a quarterly update that can be shared
- How to share research products with the communities (specifically in Lillooet)
  - Make maps that can be hung up in the communities
  - Bathymetry
  - Videos
  - Visuals – fish migration paths, First Nation territories that could be affected
- Blend local traditional knowledge with scientific
- Data – open to collaboration
  - Funding to publish data publicly
  - Accessibility considerations – some people do not have access to the internet
- Display/ share maps of First Nations territories related to areas researched
- A representation of our shared journey, important and unique contributions toward a common goal (something concrete)
  - A unifying language

#### Indigenous Engagement

- Early, meaningful, consistent inclusion of First Nations perspectives
- Have a set of protocols for ways researchers can approach First Nations
  - Know who to contact from the beginning
  - How to ask permission and get information for a particular area – even if it is not a First Nations specific area

#### Relationship Building

- How do First Nations contact/access researchers
  - Protocols for working with universities and institutes
- Collaboration is key
  - Work together to achieve common goals
  - Tripartite governance
  - Wampum belt - Indigenous practice used to mark agreements
  - "Sailing the waters together"
- Who is working where?
  - How did Lillooet people feel about people coming to work on Big Bar slide?
- Build a network of communication
  - Work together to determine what does and does not work
  - Build and maintain list of individuals, groups, and organizations
- Legacy of communication and documentation
  - Talk about lessons learned so we do not make the same mistakes

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## AFTERNOON SESSION - GROUP DISCUSSION

### 2. What are some ways that we can work together cont.

#### Oversight & Response

- Long-term planning perhaps for a central, Fraser-focused institute dedicated to overseeing the Fraser River
  - Connects people and projects
  - Governs
- Joint early response team to respond to disasters
  - Includes local community members and scientists/researchers

### Additional comments recorded during the workshop:

Comment: Archaeological evidence says that in the mid Fraser, our diet changed 5 times, in the past 2000 years, access to salmon in wetter years, ungulate bones in dryer times, it could be associated to blockages.

Comment: Been thinking of Kame terraces, sliding into the valley bottoms, there are some in the Lower Bridge River, possibly overlaid sand beds. Many of those terraces can be associated with Earth Flows that can be more vulnerable to failure at the river. Aaron Steelquist will be interested to hear this and can comment more.

Comment: Need to read Brian Hayden's Arch reports, he did a paper with June Ryder on the Big slide coming down and blocking the Fraser for up to 20 yrs-2000 years ago

Comment: The "science" which results from this work will be focused, and without context of broader histories and experiences. As a result, I worry that tangible pathways of using the "science" will falter. I hope traditional knowledge held by the First Nation's of the River can help give direction, context and meaning to the findings.

Comment: I think there are some interesting fusions of perspective, where traditional, local knowledge (e.g., shifts in food availability) may be linked to climate, or blockages, or both.

Comment: Our history says 10,000 years ago a slide came down and created Anderson and Seton lakes, I can possibly see this in the BR valley, kame terraces lower end of BR and glacial fluvial terraces in the upper end of Lower BR



## Additional publications and web links shared during the workshop:

### **Using Weather and Climate Information for Landslide Prevention and Mitigation.**

Roy C. Sidle.

[https://link.springer.com/chapter/10.1007/978-3-540-72438-4\\_15](https://link.springer.com/chapter/10.1007/978-3-540-72438-4_15)

### **Spatio-temporal characterization of slope damage: insights from the Ten Mile Slide, British Columbia, Canada.**

Davide Donati, Doug Stead, Matthew Lato & Sarah Gaib.

<https://link.springer.com/article/10.1007/s10346-020-01352-3>

### **Cost-effective Landslide Monitoring GPS System: Characteristics, Implementation and Results.**

Jorge Rodriguez, Michael T. Hendry & Renato Macciotta.

[https://www.researchgate.net/profile/Renato-Macciotta-2/publication/325608089\\_Cost-effective\\_Landslide\\_Monitoring\\_GPS\\_System\\_Characteristics\\_Implementation\\_and\\_Results/links/5b186075458515cd61aee0b2/Cost-effective-Landslide-Monitoring-GPS-System-Characteristics-Implementation-and-Results.pdf](https://www.researchgate.net/profile/Renato-Macciotta-2/publication/325608089_Cost-effective_Landslide_Monitoring_GPS_System_Characteristics_Implementation_and_Results/links/5b186075458515cd61aee0b2/Cost-effective-Landslide-Monitoring-GPS-System-Characteristics-Implementation-and-Results.pdf)

### **Field Trip Guidebook: Trip 6: Late Quaternary Geology of Southwestern British Columbia.**

John J. Claque & John L. Luternauer.

[https://www.gac-cs.ca/publications/FT\\_Late\\_Quaternary\\_Geology\\_of\\_SW\\_BC.pdf](https://www.gac-cs.ca/publications/FT_Late_Quaternary_Geology_of_SW_BC.pdf)

### **Big Bar Landslide.**

Hakai Institute.

<https://kuula.co/share/collection/7qWYT?logo=1&info=0&logosize=116&fs=1&vr=1&zoom=1&sd=1&initload=0&thumbs=1>

'Geomorphology and Stratigraphy of the Lower Bridge River' a thesis paper by Don Howes, 1972

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## APPENDIX A: WORKSHOP PARTICIPANTS

Aaron Steelquist – Simon Fraser University  
Bonnie Adolph  
Brandon Barney – Ti'q'et First Nation  
Brian Menounos – University of Northern British Columbia  
Dale Michie – Fisheries and Oceans Canada  
David Patterson – Fisheries and Oceans Canada  
Derek Heathfield – Hakai Institute  
Donald Sam – Nlaka'pamux Nation Tribal Council  
Erin Seagren – Simon Fraser University  
Evan Byrnes – Simon Fraser University  
Gerald Michell – Xwisten/Bridge River Indian Band  
Greg Witzky – Fraser Salmon Management Council  
Gregory Owens – University of Victoria  
Gwil Roberts – Fisheries and Oceans Canada  
James Hobart – Spuzzum First Nation  
Jared Davis – BC Government  
Jeff Larimer – Simon Fraser University  
Jeremy Venditti – Simon Fraser University  
Kendra Robinson – Fisheries and Oceans Canada  
Kevin Duncan – Nlaka'pamux Nation Tribal Council  
Kim Menounos – Fraser Basin Council  
Lenore Baker – Spuzzum First Nation  
Lita Gomez – Nlaka'pamux Nation Tribal Council  
Matteo Saletti – Simon Fraser University  
Max Hurson – Simon Fraser University  
Morgan Wright – Simon Fraser University  
Nick Viner – Hakai Institute  
Sara Smith Wuitchik – University of Victoria  
Shawn Chartrand – Simon Fraser University  
Sophie Louie  
Tasha Peterson – Fraser Basin Council  
Tracy Wimbush – Scwexmx Tribal Council  
Trevor Bohay – BC Government/ Big Bar Slide Project Director

## APPENDIX B: WORKSHOP AGENDA

### Fraser Landslides Research Project Community Engagement Workshop

May 10, 2022

Ti'q'et First Nation (Lillooet, BC)

Agenda Item	Speaker	Time
Welcome: introductions, opening prayer,	Greg Witzky, Kim Menounos Harold Pelegrin, Ti'q'et First Nation Elder	9:00
Roundtable (all, introduce self, territory)	Introduction to Fraser Landslides Team Roundtable – all participants introduce themselves	
What are we hoping to achieve today? (WHAT)	Kim	
Research Project Broad Overview	Jeremy	9:45
Specific Research Project Areas:	Project team members:	10:00
1. Landslides Past	Aaron Steelquist – landslides past	
2. River Flow and Morphology	Matteo Saletti – river flow	
<b>Break</b>		<b>10:30</b>
Specific Research Project Areas Cont'd		11:00
3. Fish Migration	Evan Byrne – fish migration	
4. Fish Genetics	Max Hursan – fish genetics	
<b>Lunch</b>		<b>12:30</b>
Prize Draws		
(SO WHAT?) Brainstorming: End result of project: mapped high hazard slide areas What are you interested in?	Kim, All	13:15
(NOW WHAT?) What's ahead: Years 2 & 3 project plans How we can work together?	Kim, Jeremy All	13:45-14:30
Closing	All	14:30-15:00
Adjourn		15:00