

# “Landslide Impact on Flow Dynamics, Fish Migration and Genetics of Fraser River Salmon”

## Executive Project Summary

### Background

On November 1, 2018, the Big Bar Landslide partly blocked the Fraser River, creating a hydraulic barrier to salmon passage at moderate to high flows and significantly impeding salmon migration to the Upper Fraser Basin. The Big Bar Landslide jeopardizes salmon populations in the Upper Fraser Basin until the slide material is either removed or fish passage is accommodated by an engineered solution, but *this landslide is not unique – the chance of future slides in the Fraser Canyon is real, and past landslides have likely shaped current salmon biodiversity*. The likelihood and impacts of these events on salmon remain uncertain. In order to improve our ability to respond to this and future events, *there is thus an urgent need for integrative science to assess the full impacts of the Big Bar Landslide*, identify potential future landslides and understand how fish navigate hydraulic barriers.

### Project Approach

We seek to examine the impacts of the Big Bar Landslide, and more generally river blockages that can form barriers to fish migration in the Fraser Canyon. We will apply and integrate our diverse expertise in natural hazards, geomorphology, remote sensing, salmon migration, and population genetics and incorporate traditional Indigenous perspectives to examine *past, present, and future impacts of landslides*. We will examine past impacts by mapping the locations of past landslides in the Fraser Canyon using Light Detection and Ranging (LiDAR) data and surface exposure dating to establish a chronology of river blockages that can be compared to proxies of salmon abundance in the Fraser Basin. We will examine the present impacts of the Big Bar landslide on channel morphology, flow, fish passage, and the genetics of Fraser salmon. We will establish four study sites: 1) Big Bar Landslide; 2) Hell’s Gate, where an impact has been partially mitigated by a fishway; 3) Black Canyon, as a reference site with similar pre-existing conditions to impacted sites; and 4) a site to be determined through investigation of potential hydraulic barriers. We will identify sites of potential future impacts using a combination of riverbed surveys and bank topography, and LiDAR mapping to identify sites that require further geotechnical assessment.

### Science Partnership

Our Science Partnership consists of an interdisciplinary team of researchers and leaders from non-commercial enterprises based primarily at universities and collaborative organizations in British Columbia who seek to understand risks posed by natural earth surface processes, such as landslides and hydraulic barriers, on Fraser River salmon. Our team includes world-leading experts and early career researchers in river science, natural hazards, ecology, and salmon genetics, who are excited to help conserve and restore Fraser River salmon. We propose to use innovative and cutting-edge technologies to measure and monitor earth surface processes (i.e., multibeam sonar, acoustic Doppler velocimetry, LiDAR and hyperspectral mapping, nearfield remote sensing, cosmogenic nuclide surface exposure dating), fish migration (i.e., bio-telemetry, accelerometry) and in molecular genomics (i.e., whole genome studies). Traditional Indigenous perspectives will be incorporated in the co-creation of knowledge from the outset of the project. Our proposed work will contribute to a better understanding of the infrastructure needed to enable successful fish migration across hydraulic barriers like the Big Bar Landslide and the other potential barriers that we discover.

## Project Team Members

Jeremy G. Venditti (Simon Fraser University) will lead the interdisciplinary group of researchers that includes Shawn Chartrand (Simon Fraser University), Elizabeth Dingle (Durham University), Derek Heathfield (Hakai Institute), Ben F. Koop (University of Victoria), Isaac Larsen (University of Massachusetts), Brian Menounos (University of Northern British Columbia), Jonathan Moore (Simon Fraser University), and Gregory Owens (University of Victoria). This group of academic researchers will collaborate with researchers from DFO including David Patterson and Kendra Robinson from DFO Science – Environmental Watch, Mike Hawkshaw from DFO Science and the Manager of the Big Bar Slide Monitoring Program, and Ben Sutherland from the DFO Molecular Genetics Laboratory. Kim Menounos (Fraser Basin Council) and Greg Witzky (Fraser Salmon Management Council) will lead the knowledge co-creation and engagement effort to ensure Indigenous perspectives are part of our project and to ensure our results are useful for First Nations fisheries managers, and Federal, Provincial and local governments.

Collectively the group has expertise in river dynamics (Chartrand, Dingle, Venditti), natural hazards and landslides (Chartrand, Dingle, Larsen, B. Menounos), remote sensing (Heathfield, B. Menounos) cosmogenic nuclide surface exposure dating (Larsen, Dingle), salmon ecology and biology (Hawkshaw, Moore, Patterson, Robinson,), bio-telemetry (Patterson, Robinson), salmon genetics (Owens, Koop, Sutherland), community engagement (K. Menounos), and knowledge co-creation (Witzky). Two of our team members hold Canada Research Chairs and one holds the Liber Ero Chair of Coastal Science and Management. Several team members are in leadership positions and the group includes many accomplished early career scholars working at the forefront of their respective fields.

## Anticipated Benefits

Natural hazards, such as landslides, can create crises for salmon and their management, as exemplified by the Big Bar Landslide. There is an urgent need and opportunity for integrative and collaborative science on landslides and salmon to advance management responses and proactive risk mitigation. Mapping and dating past landslides provides information on the frequency and magnitude of river blocking landslides in the Fraser River. Identifying potential sites of future landslides provides critical information necessary for geotechnical engineers to assess landslide risk, planning for future landslides and mitigation efforts. Knowing how the Big Bar Landslide impacted river morphology and flow, fish migration, and Fraser salmon genetics and risk mapping will help predict which populations are at risk of new river blockages and inform restoration efforts to maintain sustainably managed fish stocks. Further, the proposed work will inform implementation and upgrading of critical infrastructure through river engineering interventions to enable successful fish migration.

## Anticipated Outcomes

Our project will produce a better understanding of how catastrophic changes in river channel morphology (e.g., landslides, rockslides, etc.) have affected Fraser salmon in the past, how the Big Bar Landslide is presently affecting Fraser salmon, and how and where future landslides will likely affect Fraser salmon. We will produce and share i) maps of potential future landslides and probable hydraulic barriers to fish passage for the entire Fraser Canyon, ii) spatially-resolved information of environmental (topography and velocity) and biological controls (fish body size, species) on upstream fish migration, iii) evaluations of how the Big Bar Landslide affected fish genetics, and iv) information on the historic frequency and magnitude of river blockages in the Fraser Canyon and how this could have shaped present-day salmon biodiversity. ***We will communicate project findings with Indigenous fisheries organizations, communities, Provincial and Federal government emergency and fisheries planning managers, and local government agencies.***