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Sustained Impact of a Glacial Lake Outburst Flood on Winter Turbidity Regimes across the Land-Ocean Aquatic Continuum

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Rainforest rivers export large quantities of terrestrial materials from watersheds to the coastal ocean, with important implications for local ecosystems and global biogeochemical cycles. However, the impact of episodic disturbance on this process is a critical knowledge gap in our understanding of land-sea connections. Fjords represent a global hotspot for terrestrial carbon burial in marine sediments, yet the relative importance of typical riverine fluxes vs. mass wasting fluxes is uncertain and dynamic. Similarly, mass wasting events can generate both an instantaneous pulse and a sustained shift in the material export regime. Riverine sediment regimes also have important implications for freshwater ecosystems and fisheries resources. A recent mass wasting event in Bute Inlet – Homalco First Nation traditional territory and British Columbia, Canada – presents an important opportunity to quantify the sustained impact of such an infrequent large disturbance on the source-to-sink linkages between glacierized mountains, rivers, and fjords.

On November 28, 2020, a landslide in the headwaters of the Elliot Creek watershed (118 km²) triggered a glacial lake outburst flood (GLOF) that eroded 3 km² of forested land and exported large volumes of water and terrestrial materials to the lower reaches of the Southgate River watershed (1986 km²) and ultimately to the head of Bute Inlet. Here we assess river and ocean surface turbidity over four winter months following the event, in comparison to pre-event measurements taken across all seasons in recent years. River turbidity was measured on the Southgate River above and below the confluence of Elliot Creek, beginning in December 2020, and at the mouth of the Southgate and nearby Homathko Rivers prior to November 2020. Bute Inlet turbidity was measured (every month to two months) starting in May 2017.

Prior to the GLOF event, Southgate River turbidity ranged from a low of 3.3 ± 0.4 FNU in the winter to a high of 71.4 FNU in the summer meltwater period. Since the event, Southgate River turbidity has been consistently elevated ≥ 6 times background levels recorded above Elliot Creek. At the extreme, on January 13, 2021, seven weeks after the GLOF, Southgate River mean turbidity (105.2 ± 3.3 FNU) was 32 times the background (3.3 ± 0.4 FNU), equating to a sustained increase in wintertime turbidity that sometimes exceeds the historical summertime peak. Given the typical coupling of turbidity with discharge, we expect further increases in turbidity with the coming

freshet of 2021; the first meltwater season following the GLOF. These results suggest the potential for a sustained shift in the seasonal turbidity regime of the Southgate River and the estuarine waters of Bute Inlet. The elevated turbidity signals broader changes to: sediment export and carbon burial, the depth and seasonality of light penetration, river water quality, and spawning habitat quality for anadromous fish. Ongoing monitoring will be used to characterize the duration, dynamics, and potential recovery of elevated turbidity regimes across the land-to-ocean aquatic continuum in Bute Inlet.