On the demise of Whistler, Horstman and Blackcomb Glaciers, southwest British Columbia, Canada: historical use, recent change and future prospects within a mountain resort

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On the demise of Whistler, Horstman and Blackcomb Glaciers, southwest British Columbia, Canada: historical use, recent change and future prospects within a mountain resort

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ABSTRACT. Atmospheric warming is causing glaciers worldwide to retreat and disappear, with repercussions for nearby communities. Effects of glacier retreat have been especially consequential for mountain resorts such as Whistler Blackcomb, Canada, where almost 60 years of summer glacier use has been terminated due to the ongoing demise of Whistler, Horstman and Blackcomb Glaciers. Over the past five decades, Whistler, Horstman and Blackcomb Glaciers decreased in area by 95%, 75% and 60%, respectively. Using a positive degree-day model with downscaled CMIP6 data we project that Whistler Glacier will disappear within the next decade, whereas Horstman and Blackcomb Glaciers will vanish in the next 10–50 and 20–70 years, respectively. Our work implies that ski resorts that rely on glaciers will need to balance current ice preservation strategies with adaptation in light of future climate change.

"Life has few thrills equal to skiing on a glacier. The quite moderate gradient surprised us with its immod-

erate speed for an uninterrupted half mile—if champagne has feelings when uncorked, they would match ours during those moments."

Source: Don Munday, Canadian naturalist and mountaineer, on a ski descent near Whistler, British Columbia, April 1937 (Whistler Museum, 2009).

INTRODUCTION

In recent decades, the effects of atmospheric warming have been observed on glaciers worldwide (Hock and Huss, 2021). Glacier loss has been especially challenging for mountain resorts that rely on income generated by glacier-related activities (Gagné and others, 2014). This includes the Whistler Blackcomb mountain resort in British Columbia, Canada.

The landscape of Whistler and Blackcomb Mountains in the Coast Mountains of southwest British Columbia, Canada (Fig. 1a), has been called a skier's paradise (Whistler Museum, 2009), with its terrain carved by the Cordilleran Ice Sheet (Clague and others, 1989; Church and Ryder, 2010) and its abundant snowfall supplied by the orographic precipitation of North Pacific weather systems (Loukas and Quick, 1994).

The first documented ski descent of Whistler Mountain occurred in 1933 (Whistler Museum, 2009), over 30 years before becoming a ski resort. The Whistler Blackcomb ski resort began as a bid to bring the 1968 Olympics to the region (Vogler, 2016). Whistler Mountain first opened for commercial alpine skiing on 15 January 1966 (Whistler Museum, 2009), followed by Blackcomb Mountain on 4 December 1980. Starting in 1966, the glaciers within the Whistler Blackcomb area boundary provided access to the only mid-summer skiing operation in Canada, with various programs for freestyle and mogul skiing, snowboarding and downhill skiing.

While much of the glacier ice within the Whistler Blackcomb resort has already vanished, the remaining glaciers hold cultural and aesthetic value for the resort and the nearby community. However, continued warming threatens their existence. Here we recount the historical use of Whistler, Horstman and Blackcomb Glaciers, and we use two methods to estimate when they will disappear. We first document glacier area changes from 1973 to 2024, and then apply a crude mass-balance model to estimate the time to deglaciation.

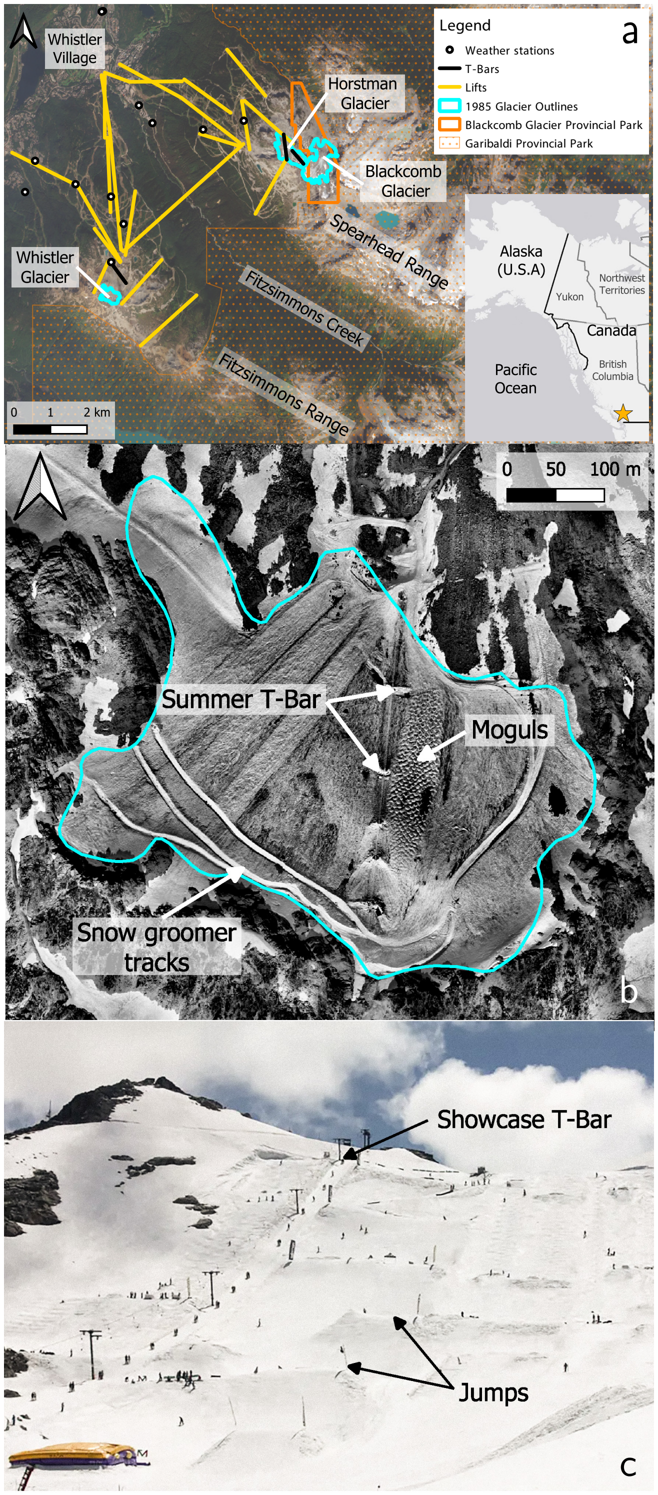

Fig. 1. Study area in the Traditional Territory of the Sḵwx̱wú7mesh Úxwumixw and Líl̓wat Nation, southwest British Columbia, Canada. (a) Whistler, Horstman and Blackcomb Glaciers shown in the context of the Whistler Blackcomb resort. Image credit: ESA, contains modified Copernicus Sentinel data (2024). (b) Whistler Glacier during 1989 summer operations. Image credit: property of the Province of British Columbia used with permission. (c) Horstman Glacier during 2015 summer operations. Image credit: Whistler Museum.

USE OF WHISTLER, HORSTMAN AND BLACKCOMB GLACIERS

The 1966 opening of the Alpine T-Bar (no longer present), located near the peak of Whistler Mountain (Garibaldi Lifts, 1970), made Whistler Glacier accessible to alpine skiers. The first glacier ski camp was held the following summer (Whistler Museum, 2024a) (Fig. 1b). Summer skiing on Whistler Glacier came to an end in the late 1990s due to glacier retreat and low summer snow levels (personal communication from A. De Jong, 2025). Since then, the entrances to Whistler Bowl (Fig. 2a), located west of the peak of Whistler Mountain, have become much steeper or no longer accessible, including the site of the terminal tower for the summer-camp t-bar (personal communication from C. Jewett, 2025). Locals note that one of the steepest runs on the mountain, The Saddle (Fig. 2a), has become even steeper in recent years due to glacier downwasting, leading the resort to increase the difficulty level of the run in 2021 from intermediate to advanced (Whistler Blackcomb, 2021).

Horstman Glacier (Fig. 1a), became accessible to skiers with the addition of the High Alpine T-Bar (no longer present) in 1985, located on the south-western flank of Blackcomb mountain (Vogler, 2016). The Glacier T-Bar (later renamed Horstman T-Bar) was installed directly on Horstman Glacier in 1987 (Fig. 2b). Summer camps (Fig. 1c) were held on Horstman Glacier starting in 1988 (Brown, 2017). After Whistler and Blackcomb resorts merged in 1997, summer camps that previously took place on Whistler Glacier moved to Horstman Glacier (personal communication from A. De Jong, 2025). Since the towers for Horstman T-Bar were mounted directly on glacier ice, they had to be repositioned every year in response to seasonal snowfall and glacier evolution. The resort experimented with several interventions to save the t-bar, including the installation of a snow fence on the ridge to encourage greater snow accumulation on the glacier, a snowmaking experiment on the upper glacier to supplement natural snowfall and geotextiles to protect the ice under the towers and the loading and unloading stations (personal communication from A. De Jong, 2025). Despite these efforts, the t-bar was permanently removed in 2020 as the evolving glacier profile caused excessive cable tension and created a dangerously steep exit from the lift (Sorensen, 2020). Horstman Glacier was not opened for summer skiing in 2024 due to low snowfall, marking the first time in decades that conditions resulted in neither Whistler nor Blackcomb resorts having a summer ski season (Whistler Museum, 2024b; Tibballs, 2024). In March 2025, summer ski camps were indefinitely cancelled due to the diminishing glacier and snowpack (Song, 2025).

The 1988 installation of Showcase T-Bar on the upper part of Horstman Glacier facilitated access to

Blackcomb Glacier (Fig. 1a), which was originally within the adjacent Garibaldi Provincial Park and therefore unpatrolled and lacking avalanche control (Maxwell, 2000; Blackcomb Ski Corporation, 1988). The dangers were considerable and included a steep drop into a narrow valley with frequent avalanches, prompting Blackcomb resort to petition the British Columbia Ministry of Environment and Parks to redraw the provincial park boundaries and develop the glacier for skiing (Maxwell, 2000). The outcome was the creation of Blackcomb Glacier Provincial Park in 1990. In recent years, access to the glacier via Showcase T-Bar (Fig. 2b) has been limited to the late-winter ski season. In 2025, for example, the t-bar did not open until 22 March. The primary access point to Blackcomb Glacier has also evolved as glacier downwasting has steepened the traditional entrance. The changes in operations and available terrain at Whistler Blackcomb has been woven into the collective experience of resort visitors and residents. We now provide a more quantitative assessment of both past and future ice loss to provide context to the experiential loss felt so strongly by the Whistler community.

GLACIER CHANGE MAPPING: 1973–2024

Glacier delineation

We manually digitised glacier outlines (e.g. Paul and others, 2013) in QGIS. Uncertainties were assessed as the product of the perimeter length and image resolution (see Table S1 in Supp. Mat. for imagery details) (Hoffman and others, 2007; Burns and Nolin, 2014). In areas where seasonal snow cover obscures the glacier margin, we retain the outline from the previous year for which we have satellite imagery of the same type, under the assumption that no glacier advance occurs during the period of study. Any visible nunataks were outlined and their areas subtracted from the total area of the glacier. We linearly extrapolate the disappearance dates of Whistler, Horstman and Blackcomb Glaciers using unweighted and weighted least-squares regressions of glacier area as a function of time, with weights that are inversely proportional to the uncertainties, or the logarithm of uncertainties (Figure 2c).

The 1985 glacier outline was adopted from Bevington and Menounos (2022); it was originally drawn using digital elevation models from the Terrain Resource Information Mapping (TRIM) dataset of the Government of British Columbia, and improved with Landsat imagery (Bolch and others, 2010). Inspection of the aerial imagery revealed that a landslide occurred and deposited debris along the upper margin of Blackcomb Glacier sometime between 1973 and 1990. This debris-covered ice was excluded from the outlines of RGI 7.0 (2023), and from the Bevington and Menounos (2022) inventory; therefore this area was also excluded from subsequent outlines.

Results

In the last two decades, Whistler Glacier has fragmented into numerous pieces clustered into eastern and western sectors (Fig. 2a). We include only the eastern sector in values reported here for consistency with RGI 7.0 and the inventory of Bevington and Menounos (2022) (see Table S2 in Supp. Mat. for western-sector values). Whistler Glacier area has declined ∼95% from $0.224 \pm 0.001\,\mathrm{km}^2$ in 1973 to $0.012 \pm 0.002\,\mathrm{km}^2$ in 2024, and dropped below the United States Geological Survey (USGS) threshold of $0.1\,\mathrm{km}^2$ (USGS (2025), also used by Schiefer and others (2008)) prior to 2005 (Figure 2c). Simple extrapolation of area measurements since 1973 suggests glacier disappearance within roughly a decade (Table 1, Method 1).

Over time, Horstman Glacier has been narrowing and retreating, and at present, only some of the towers for Showcase and former Horstman T-Bars are underlain by glacier ice (Fig. 2b). The 2018 image shows that the use of geotextiles under the t-bar helped to preserve a portion of the glacier tongue. Horstman Glacier has lost nearly 75% of its area since 1973, declining from $0.467 \pm 0.001\,\mathrm{km}^2$ to $0.121 \pm 0.008\,\mathrm{km}^2$ in 2024, with extrapolation crossing the $0.1\,\mathrm{km}^2$ threshold prior to 2035 and reaching zero prior to 2050 (Figure 2c, Table 1, Method 1). By plotting the glacier area through time, we observe a change in retreat rate around 2011, consistent with the observations from Bevington and Menounos (2022), who mapped glacier change at a regional scale (see Fig. S3 in Supp. Mat. for piecewise regression).

The evolution of Blackcomb Glacier is geometrically complex (Fig. 2b) and marked by the emergence of nunataks in its upper reaches. Earlier imagery (1973 and 1990) shows that Blackcomb Glacier became disconnected from two smaller ice bodies to the southeast some time between 1990 and 2005 (their area not included here for consistency with other inventories). Blackcomb Glacier has lost close to ∼60% of its area from 1973 ($0.725 \pm 0.002\,\mathrm{km}^2$) to 2024 ($0.307 \pm 0.019\,\mathrm{km}^2$). By extrapolating the linear fit to the area change through time, we project that the glacier area will drop below $0.1\,\mathrm{km}^2$ as early as ∼2050 and reach zero by 2070 (Table 1, Method 1). The apparent increase in glacier extent around 2016–17 is likely an artifact due to the change in image resolution and increased snow cover during the winters of 2015/16 and 2016/17.

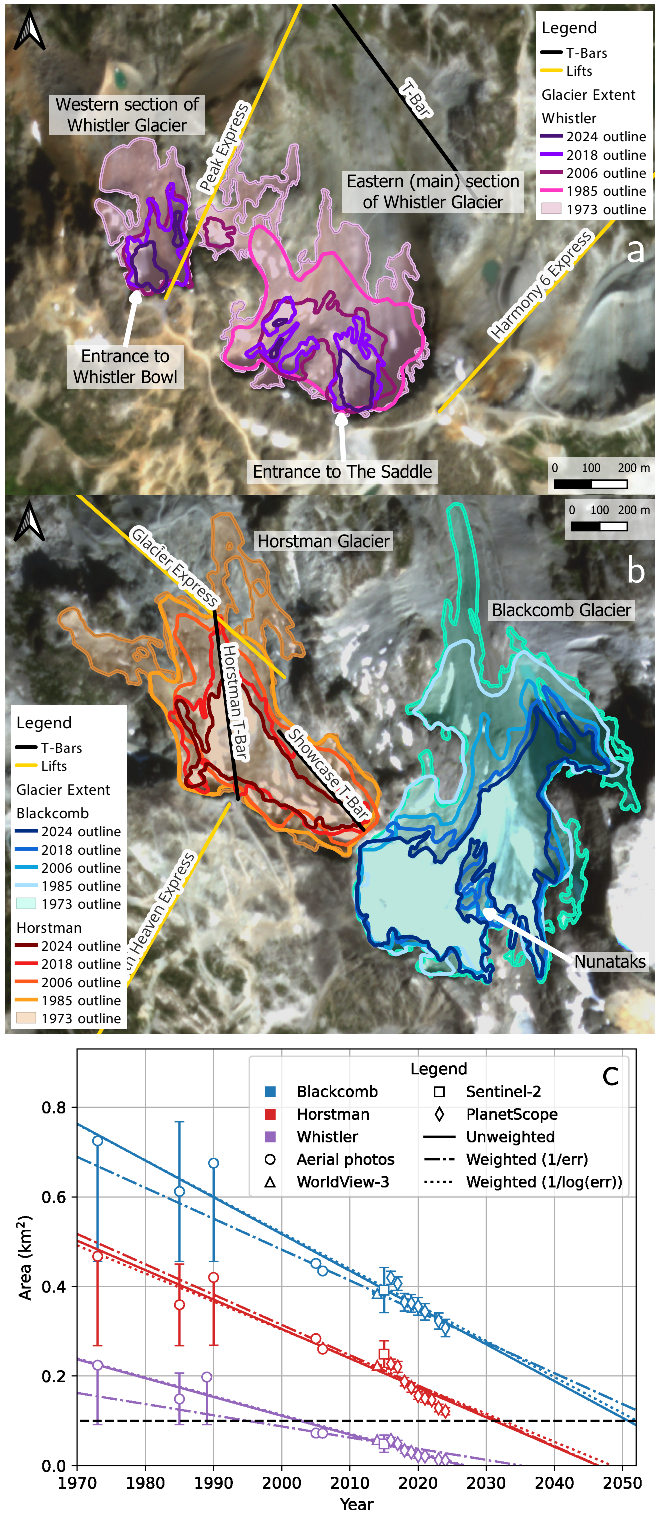

Fig. 2. 1973–2024 Glacier extents mapped from airborne and satellite imagery for 1973, 1985, 2006, 2018, 2024. Image credit: ©2024 Planet Labs PBC. (a) Whistler Glacier. (b) Horstman and Blackcomb Glaciers. (c) Timeseries with weighted and unweighted least-squares linear regressions. Weights are inversely proportional to uncertainties (dashed-dotted lines), or the logarithm of uncertainties (dotted lines). Note asymmetric uncertainties in 1973, 1989, 1990, where snow cover permitted only an upper bound on area. See Fig. S1, S2 in Supp. Mat. for all glacier outlines.

Table 1. Estimated glacier disappearance dates. Method 1: Extrapolation of glacier-area regressions (Fig. 2c). Method 2: Net balance calculated with degree-day model and constant winter balance applied to Farinotti and others (2019) (F) and Millan and others (2022) (M) ice-thickness models for CMIP6 SSP2 and SSP5.

Glacier	Method 1	Method 2, SSP2	Method 2, SSP5
Whistler	2027–35	2018–25^F	2018–25^F
		2032–45^M	2032–42^M
Horstman	2046–49	2038–46^F	2037–44^F
		2059–70^M	2055–63^M
Blackcomb	2063–70	2046–53^F	2044–49^F
		2080–91^M	2071–78^M

PROJECTIONS OF GLACIER VOLUME LOSS

Mass-balance model

We use a classical degree-day model to relate positive air temperatures to surface ablation (e.g. Braithwaite and Olesen, 1989; Hock, 2003), with a single degree-day factor (DDF) for snow, ice and firn (due to data limitations as described below). We apply the model to the mean elevation of each glacier to crudely estimate a uniform value of glacier-wide ablation. This broad-brush approach neglects the complexities of both glacier geometry and surface energy balance. We compute degree-day factors for Horstman and Blackcomb Glaciers using a combination of (1) snow accumulation measurements adjusted to the mean glacier elevations with an accumulation lapse rate, (2) net-balance measurements derived from repeat laser altimetry surveys during autumn of 2017, 2020 and 2024 and an assumed surface density of $850 \pm 60\,\mathrm{kg\,m^{-3}}$ (Huss, 2013) to convert elevation to mass change and (3) positive degree-days (PDDs) computed using downscaled air temperatures. We estimate ablation by differencing (1) and (2). In the absence of net-balance measurements for Whistler Glacier, we apply the average DDF from Horstman and Blackcomb Glaciers to Whistler Glacier.

To compute positive degree-days (PDDs), we use air temperatures downscaled to $\sim$10 km from CMIP6 (Coupled Model Intercomparison Project, Phase 6) by the Pacific Impacts Climate Consortium (PCIC, 2023). We use historical CMIP6 data back to 2000, and the SSP2-4.5 scenario (Shared Socio-economic Pathway 2, $4.5\,\mathrm{W\,m^{-2}}$ radiative forcing) from 2015–2024 and to compute PDDs and therefore DDFs. From 2025–2100 we explore very high (SSP5-8.5), low (SSP1-2.6) and intermediate (SSP2-4.5) emissions scenarios.

We estimate the mean 2017–24 accumulation using snowfall measurements collected by Whistler Blackcomb (unpublished data) at Pig Alley, a weather station on Whistler Mountain at 1640 m a.s.l. These data are converted to mass using the mean snow density of $90.5\pm34.7\,\mathrm{kg\,m^{-3}}$ measured at the same station from snowboard core samples between 1990–2016 (Barton, 2017). For simplicity, we assume accumulation remains constant in the future and equal to the 1971–2024 average of 1030 cm per year. A lapse rate is applied to this value to estimate future accumulation across the study glaciers. Snow accumulation from the weather station and air temperatures from the downscaled CMIP6 data are adjusted to the mean elevations of each glacier and taken to represent glacier-wide values. We use accumulation and temperature lapse rates ($447\,\mathrm{cm\,a^{-1}\,km^{-1}}$ and $-5.74\,°\mathrm{C\,km^{-1}}$, respectively) determined from local station data (PCIC, 2025; see Fig. S4 in Supp. Mat. for map of stations).

Glacier volume projections are made by applying our simple mass-balance model to the Farinotti and others (2019) and Millan and others (2022) ice-thickness models (hereafter referred to as simply “Farinotti” and “Millan” models) for each glacier under no-flow assumptions, as justified by ITS_LIVE time-averaged velocities less than $0.35\,\mathrm{m\,a^{-1}}$ for all three glaciers (Gardner and others, 2025a,b). Projections are made from different years (2000, 2007, 2015) to account for the ranges of acquisition dates of the surface DEMs used by the Farinotti and Millan models.

Results

The degree-day factors are $1.60\,\mathrm{mm\,w.e.\,°C^{-1}\,d^{-1}}$ for Horstman Glacier and $1.72\,\mathrm{mm\,w.e.\,°C^{-1}\,d^{-1}}$ for Blackcomb Glacier, with the average of $1.66\,\mathrm{mm\,w.e.\,°C^{-1}\,d^{-1}}$ assumed for Whistler Glacier (see Table S3 in Supp. Mat. for net balance, ablation and PDD values).

In the scenarios with the ice thickness initialised with the Farinotti model in 2000 and 2007, Whistler Glacier is projected to have already disappeared, or to disappear imminently (see Fig. 3c). The scenarios with the Millan model initialised between 2000 and 2015 are more optimistic and project the disappearance of Whistler Glacier between 2032–45 for CMIP6 SSP2, which is the most plausible of our chosen scenarios based on current policies (Hausfather and Peters, 2020). See Table 1 (Method 2) for the range of disappearance dates for SSP2 and SSP5 (SSP1 can be found in Supp. Mat.). Our model projects that Horstman Glacier will disappear between 2038–46 when initialised with the Farinotti model under the SSP2 scenario. Using the Millan model, Horstman Glacier persists until 2059–70 under the SSP2 scenario. As the largest of the three glaciers, Blackcomb Glacier is more sensitive to the choice of ice thickness model and therefore shows the widest range of disappearance dates. The SSP2 scenario for Blackcomb Glacier leads to its projected disappearance between 2046–53 for the Farinotti model and 2080–91 for the Millan model.

The parameters that define the widest range of disappearance dates are the ice thickness, initialisation date, and for the larger glaciers the SSP scenario. When applied to both Farinotti and Millan models, different initialisation dates and all CMIP6 SSP scenarios, the ice density range of 790–910 kg m^{-3} produces only a two-year variation in disappearance dates. With the Farinotti model, SSP1 and SSP2 produce no variation in disappearance dates for Whistler and Horstman Glaciers, and one year difference for Blackcomb; with the Millan model, the variation is 3–4 years for Horstman Glacier, 10 to >12 years for Blackcomb Glacier and nil for Whistler Glacier. The variation in disappearance dates between SSP2 and SSP5 is larger, with differences up to four years for Farinotti, and up to 12 years for Millan.

The sensitivity of the mass-balance model to snow density, annual accumulation, and temperature and accumulation lapse rates are tested by varying each quantity by ±20%. For the reference case of the Millan model and CMIP6 SSP2 scenario initialised in 2007, annual accumulation produces a variation of approximately 4–9 years, 4–8 years for the temperature lapse rate, 1–2 years for snow density and 0–2 for the accumulation lapse rate (see Table S6 in Supp. Mat. for associated DDFs).

Despite the large uncertainty in parameters, the area loss rates generated by the mass-balance model are highly comparable to the observed area loss rates (see Table S7 in Supp. Mat.).

OUTLOOK

With the disappearance of Whistler Glacier seemingly imminent or in the next decade, and that of Horstman and Blackcomb glaciers to follow in the next 10–50 and 20–70 years, respectively, ongoing adaptation will be required to maintain safe winter access to terrain and to replace the summer surge in alpine tourism that once flourished from these glaciers. Whistler, Horstman and Blackcomb glaciers have served as ecological, aesthetic, recreational and economic resources, whose recent history illustrates the progression from preservation to adaptation in the face of their committed disappearance.

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This work was inspired by citizen scientists and Whistler community members who have been monitoring local glacier change for over 50 years. Arthur De Jong and Cathy Jewett generously provided information

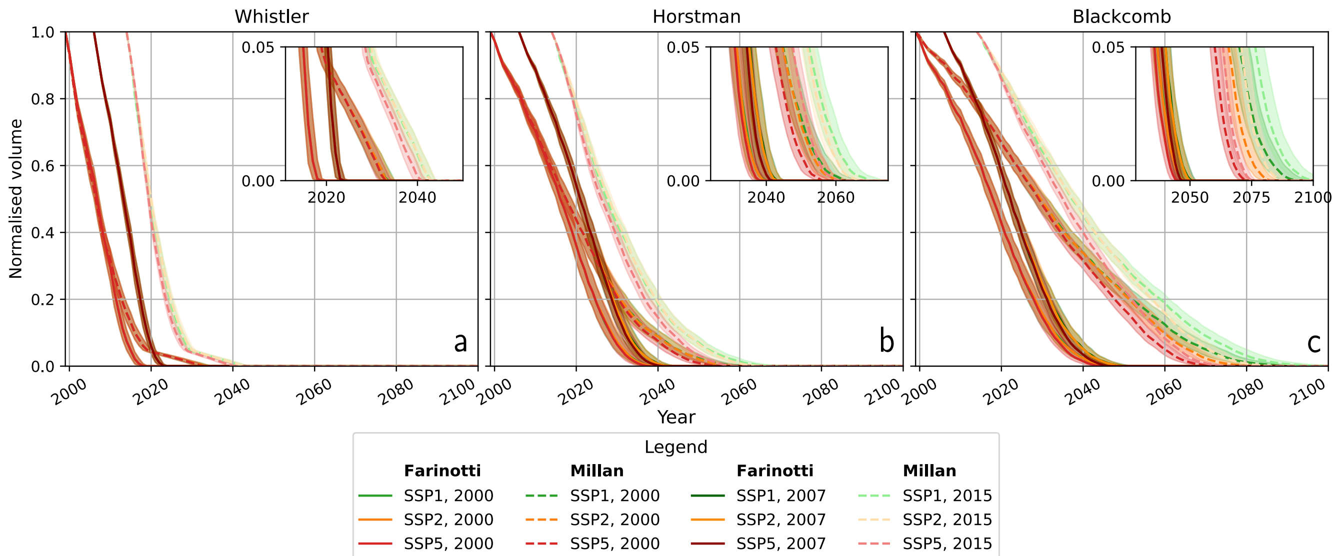

Fig. 3. Normalised glacier volume change over time. (a) Whistler Glacier. (b) Horstman Glacier. (c) Blackcomb Glacier. Scenarios initialised with the Farinotti model (starting in 2000 and 2007) are shown as solid lines, while those initialised with the Millan model (starting in 2000 and 2015) are shown as dashed lines. Scenarios SSP1, SSP2 and SSP5 are represented using different colours (see legend). The insets on each panel are zoomed to the normalised volume between 0 and 0.05 and the disappearance date for each scenario. See Fig. S7 in Supp. Mat. for spatially distributed projections of ice thickness.

on the historical context of the study. We would like to thank the Whistler Museum for providing the 2015 image of Horstman Glacier and insights on the history of Whistler Blackcomb. We are grateful to the avalanche forecasters at Whistler Mountain for the snowfall data used in this study. Financial support was provided by the Natural Sciences and Engineering Research Council of Canada (GF, BM), Simon Fraser University (C.Monty, GF), including through a BC Graduate Scholarship to C.Monty, as well as the Tula Foundation (Hakai Institute; BM) and the Natural Hazards and Climate Change Geoscience Program at NRCan-GSC (JC).

AUTHOR CONTRIBUTIONS

C.Monty conceived of the project, performed all calculations, created the figures and drafted text. GF oversaw all aspects of the work and revised the text. BM supplied the processed LiDAR data, Planet Lab imagery, BC aerial photos, consulted on the methods and provided feedback on the text. C.Mathias processed the BC aerial photos and generated the ortho imagery. JC consulted on methods and revised the text.

DATA & CODE AVAILABILITY

Data and code for this article will be made available upon publication. Access to other publicly available datasets is described in Supp. Mat.

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SUPPLEMENTARY MATERIAL

The supplementary material for this article will be linked upon publication.