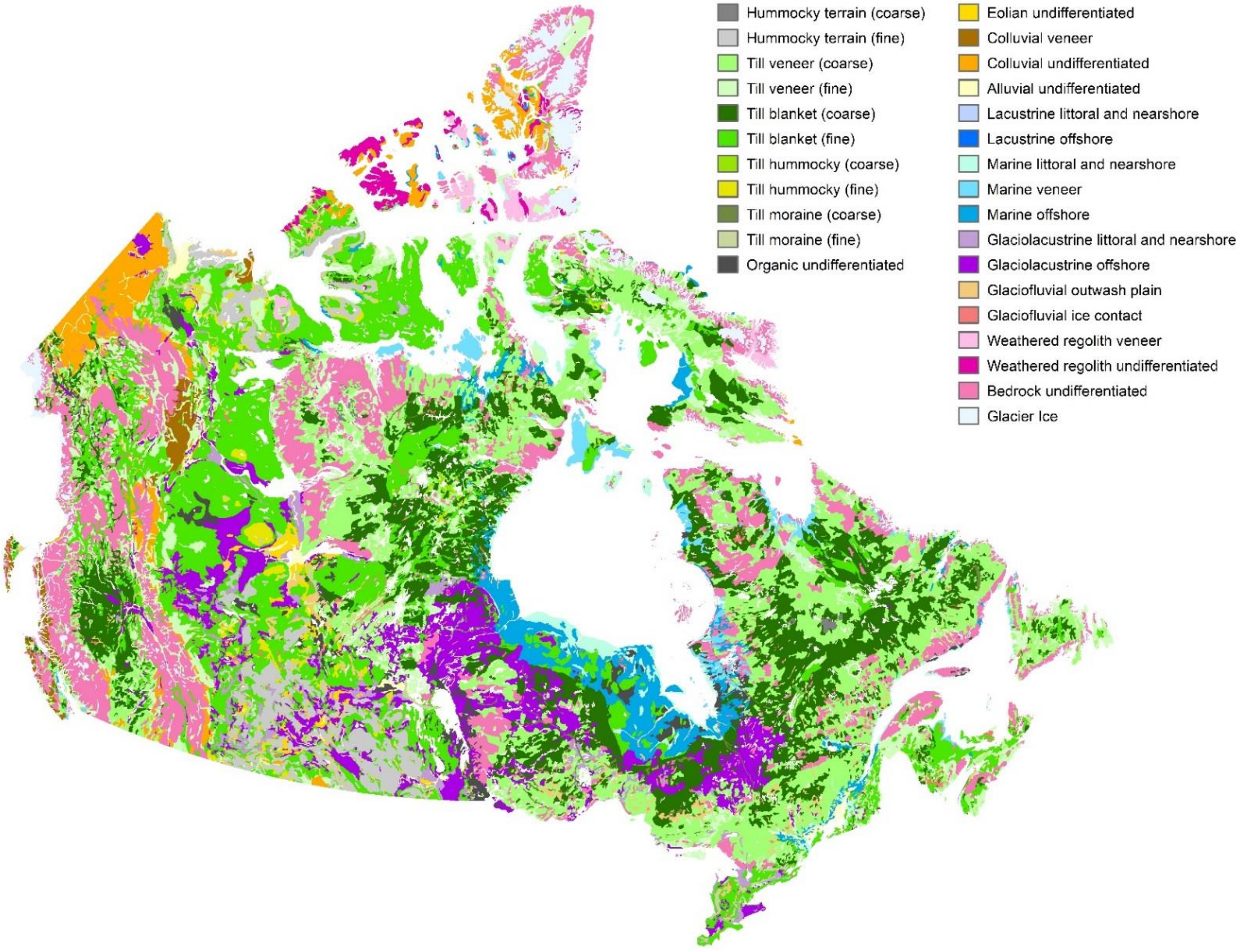
Hummocky terrain (coarse)
Hummocky terrain (fine)
Till veneer (coarse)
Till veneer (fine)
Till blanket (coarse)
Till blanket (fine)
Till hummocky (coarse)
Till hummocky (fine)
Till moraine (coarse)
Till moraine (fine)
Organic undifferentiated
Eolian undifferentiated
Colluvial veneer
Colluvial undifferentiated
Alluvial undifferentiated
Lacustrine littoral and nearshore
Lacustrine offshore
Marine littoral and nearshore
Marine veneer
Marine offshore
Glaciolacustrine littoral and nearshore
Glaciolacustrine offshore
Glaciofluvial outwash plain
Glaciofluvial ice contact
Weathered regolith veneer
Weathered regolith undifferentiated
Bedrock undifferentiated
Glacier Ice

Figure S1. The modified surficial material units used in the models. The Surficial geology of Canada map includes 25 material units (Geological Survey of Canada, 2014). Glaciomarine nearshore (Gmn) and glaciomarine offshore (GMo) units were combined with Marine units (Mn; Mo). The Quaternary volcanic rocks (V) unit was combined with the bedrock undifferentiated (R) unit. Hummocky terrain (i.e. controlled moraines, Evans (2009)) from the Glacial map of Canada (Prest et al., 1968) were overlaid onto the revised units. This was necessary because the Till hummocky (Th) and Till moraine (Tm) units on the Surficial geology of Canada map generally underestimate the extent of thicker hummocky till and till moraines that are known to include buried glacier ice.

Shield-derived tills in Canada are typically coarse-grained, whereas those derived from sedimentary rock include higher silt and clay fractions (Fulton, 1989). Thus, till units were differentiated based on the source bedrock to better constrain glacial deposit grain size, which is important for ground ice formation and preservation. Rock types from The Geological map of Canada (Wheeler et al., 1996) were classified as hard (e.g., metamorphic, volcanic, intrusive) or soft (i.e., sedimentary). Till units underlain by hard rock were considered to be predominantly coarse-grained with a higher fraction of sand and clasts, whereas tills overlying sedimentary rock were considered to include a higher silt and clay content (Fulton, 1989).

In some small areas on the Glacial map of Canada (e.g., southeast Victoria Island), hummocky terrain units are superimposed over formerly marine-inundated areas, below the regional limit of inundation. In these few cases, the small polygons were removed to account for the melt of massive ice and icy sediment due to inundation.

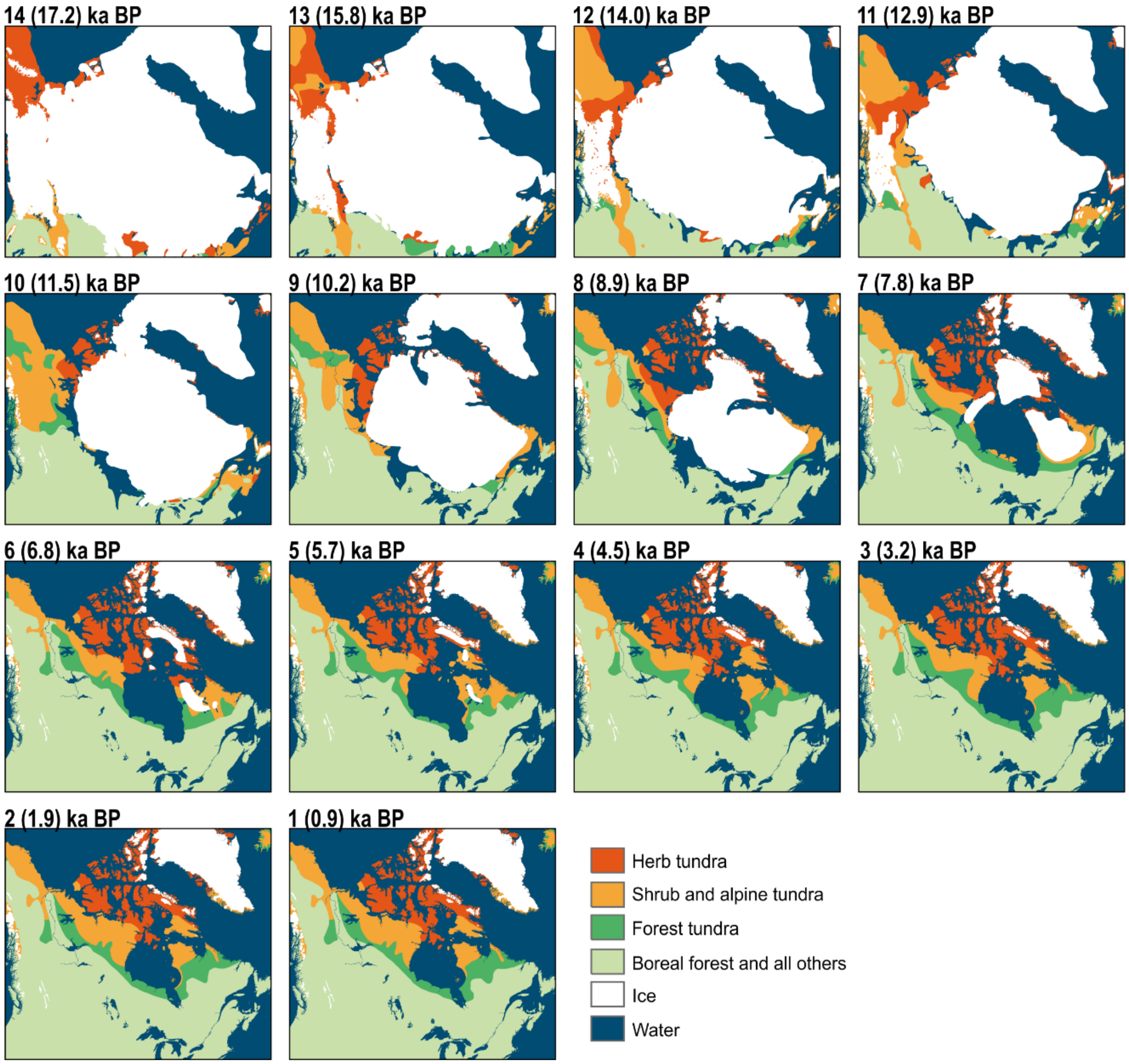

Figure S2. Configurations of biomes, ice, and water for the 14 time steps used in the models (modified from Dyke et al., 2004). The leftmost numerals indicate uncalibrated ^{14}C ages, and calibrated ages are shown in parentheses. Time steps in the wedge ice accumulation calculation are every 1.0 ^{14}C ka from 14 ^{14}C ka BP to 1.0 ^{14}C ka BP (Dyke et al., 2004). Each time step spans 1.2 cal ka on average. The radiocarbon years were calibrated using CALIB 5.0.1. software (e.g., Stuiver et al., 2018).

Figure S3. Locations referred to in text.

Table S1. Initial massive ice values for surficial materials. The values represent high (50), medium (20), low (10), and no (0) abundance.

	Surficial material unit	**Initial value**
1	HC: Hummocky Terrain (coarse)	20
2	HF: Hummocky Terrain (fine)	50
3	TvC: Till veneer (coarse)	0
4	TvF: Till veneer (fine)	0
5	TbC: Till blanket (coarse)	10
6	TbF: Till blanket (fine)	20
7	ThC: Till hummocky (coarse)	20
8	ThF: Till hummocky (fine)	50
9	TmC: Till moraine (coarse)	20
10	TmF: Till moraine (fine)	50
11	O: Organic undifferentiated	0
12	E: Eolian undifferentiated	0
13	Cv: Colluvial veneer	0
14	C: Colluvial undifferentiated	0
15	A: Alluvial undifferentiated	0
16	Ln: Lacustrine littoral and nearshore	20
17	Lo: Lacustrine offshore	0
18	Mn: Marine littoral and nearshore	0
19	Mv: Marine veneer	0
20	Mo: Marine offshore	0
21	GLn: Glaciolacustrine littoral and nearshore	0
22	GLo: Glaciolacustrine offshore	0
23	GFp: Glaciofluvial outwash plain	20
24	GFc: Glaciofluvial ice contact	20
25	Wv: Weathered regolith veneer	0
26	W: Weathered regolith undifferentiated	0
27	R: Bedrock undifferentiated	0

Notes: Massive ice is considered absent in till veneers (TvC; TvF), which are commonly mapped when overburden is thin, discontinuous, and includes bedrock outcrops (Geological Survey of Canada, 2014). Therefore, these deposits are likely too thin to preserve buried glacier ice, and unlikely to be underlain by coarse-grained sediment permitting formation of intrasedimental ice. Fine-grained till moraine (TmF), hummocky till (ThF), and hummocky terrain (HF) units are assigned high values as they are associated with ice margins where conditions are highly favourable for the burial of basal glacier ice and the development of intrasedimental ice (Dyke and Savelle, 2000; Evans, 2003; French and Harry, 1988; Rampton, 1988). Medium values are assigned to fine-grained till blanket units (TbF). Equivalent coarse-grained tills (TmC, ThC, HC, and TbC) have medium to low abundance values, as they are typically thinner and underlain by indurated bedrock. Glaciofluvial sediments have medium massive ice values, as glacier ice may be buried by outwash deposits (Evans, 2003). Massive ice is considered absent in lacustrine and glaciolacustrine (nearshore and offshore) sediments and in marine sediments. Nearshore lacustrine sediments, however, have medium massive ice values. These small units are mapped primarily near the western Arctic coast, where till in fact overlies much of the terrain between the numerous lakes in the region. Massive ice is considered absent in colluvial deposits (C; Cv), undifferentiated organic material (O), eolian sediments (E), weathered regolith, and bedrock, as the environmental settings in which they accumulate are unlikely to result in the formation or preservation of buried glacier ice or intrasedimental ice.

Table S2. Biome-modified massive ice values. HT = herb tundra, ST = shrub tundra, AT = alpine tundra, FT = forest tundra, BF = boreal forest. The values represent high (50), medium (20), low (10), and no (0) abundance.

	Surficial material unit	**Initial value**	**Biome-modified values**			
			HT	*ST, AT*	*FT*	*BF and others*
1	HC: Hummocky Terrain (coarse)	20	20	20	10	5
2	HF: Hummocky Terrain (fine)	50	50	50	20	10
3	TvC: Till veneer (coarse)	0	0	0	0	0
4	TvF: Till veneer (fine)	0	0	0	0	0
5	TbC: Till blanket (coarse)	10	10	10	5	0
6	TbF: Till blanket (fine)	20	20	20	10	5
7	ThC: Till hummocky (coarse)	20	20	20	10	5
8	ThF: Till hummocky (fine)	50	50	50	20	10
9	TmC: Till moraine (coarse)	20	20	20	10	5
10	TmF: Till moraine (fine)	50	50	50	20	10
11	O: Organic undifferentiated	0	0	0	0	0
12	E: Eolian undifferentiated	0	0	0	0	0
13	Cv: Colluvial veneer	0	0	0	0	0
14	C: Colluvial undifferentiated	0	0	0	0	0
15	A: Alluvial undifferentiated	0	0	0	0	0
16	Ln: Lacustrine littoral and nearshore	20	20	20	10	5
17	Lo: Lacustrine offshore	0	0	0	0	0
18	Mn: Marine littoral and nearshore	0	0	0	0	0
19	Mv: Marine veneer	0	0	0	0	0
20	Mo: Marine offshore	0	0	0	0	0
21	GLn: Glaciolacustrine littoral and nearshore	0	0	0	0	0
22	GLo: Glaciolacustrine offshore	0	0	0	0	0
23	GFp: Glaciofluvial outwash plain	20	20	10	5	0
24	GFc: Glaciofluvial ice contact	20	20	10	5	0
25	Wv: Weathered regolith veneer	0	0	0	0	0
26	W: Weathered regolith undifferentiated	0	0	0	0	0
27	R: Bedrock undifferentiated	0	0	0	0	0

Notes: Massive ice melt during the Holocene is simulated using biome distributions at 14 time steps from 14 ka BP to 1 ka BP (c. 17.2 to 0.9 cal ka BP) from the maps of Dyke et al. (2004). The initial massive ice values are reduced in all surficial materials when tundra biomes transition to forest tundra. For example, the values in fine-grained till moraine and hummocky deposits (TbF, ThF, HF) are reduced from high values in herb, shrub, and alpine tundra to medium values in forest tundra, and similar relative reductions occur within the other till units. This represents the melt of massive ice during Holocene climatic changes. During this period, the active-layer thickness increased and tree line advanced in the western Arctic. The increase in active layer thickness lead to widespread thermokarst lake formation in northwestern Canada (Burn, 1997; Rampton, 1988). The initial medium value in glaciofluvial outwash plain and ice contact sediments (GFp, GFc) is reduced in shrub tundra and again in forest tundra, as the high thermal conductivity of coarse sediments would likely facilitate permafrost thaw to significant depths. The development of massive intrasedimental ice following emergence is considered unlikely in most marine-inundated areas. This is because in the majority of these settings, including large areas of Victoria Island, Prince of Wales Island, western Baffin Island, and mainland areas surrounding Coronation and Queen Maud Gulf, the retreating ice front was far from the emerging shoreline (Dyke et al., 2004). Therefore, abundant glacial meltwater sources were not available as permafrost aggraded into newly-exposed sediments as the sea level receded. This configuration would preclude the development of large, pressurized aquifers resulting from porewater expulsion or glacial meltwater driven toward the permafrost freezing front (Mackay and Dallimore, 1992; Rampton, 1988).

Table S3. Locations of massive ice identified in the literature. The list should not be considered exhaustive but includes key publications from areas with observations. Lat/long coordinates are approximate.

Location	Lat.	Long.	Reference
Buried glacier ice			
Banks Island	72°50'	110°00'	(Lakeman and England, 2012)
SW Banks Island	71°43'	124°05'	(French and Harry, 1988, 1990)
NE Victoria Island	73°11'	113°59'	(Lorrain and Demeur, 1985)
NE Victoria Island	73°08'	114°16'	(Lorrain and Demeur, 1985)
SW Victoria Island	71°00'	117°00'	(Dyke and Savelle, 2000)
SW Victoria Island	71°00'	117°00'	(Sharpe, 1988)
Summer Island	69°42'	134°15'	(Murton et al., 2005)
Richards Island	69°42'	134°29'	(Murton, 2005)
Tuktoyaktuk Coastlands	69°04'	134°45'	(French and Harry, 1990)
Tuktoyaktuk Coastlands	69°04'	134°45'	(Murton et al., 2005)
Richards Island	69°06'	134°36'	(Dallimore and Wolfe, 1988)
Eskimo Lakes	69°14'	132°09'	(Murton et al., 2005)
Tuktoyaktuk Coastlands	69°00'	133°30'	(Gowan and Dallimore, 1990)
Slave Geological Province	64°04'	111°09'	(Wolfe et al., 2017)
Yukon Coastal Plain	69°34'	139°01'	(Fritz et al., 2011; Pollard, 1990)
Yukon Coastal Plain	69°34'	138°51'	(Pollard, 1990)
central Yukon	64°47'	138°21'	(Lacelle et al., 2007)
Bylot Island	73°09'	79°57'	(Coulombe et al., 2015)
Coronation Gulf	68°25'	119°35'	(St-Onge and McMartin, 1995)
SE Baffin Island	66°08'	65°42'	(Hyatt et al., 2003)
Contowyto Lake	66°02'	111°07'	(Wolfe, 1998)
Massive intrasedimental ice			
Tuktoyaktuk Coastlands	69°56'	128°59'	(French and Harry, 1990)
Richards Island	69°42'	134°29'	(Murton, 2005)
Tuktoyaktuk Coastlands	69°28'	132°37'	(Mackay and Dallimore, 1992)
Tuktoyaktuk Coastlands	69°24'	133°07'	(Mackay and Dallimore, 1992)
Tuktoyaktuk Coastlands	69°18'	132°35'	(Mackay and Dallimore, 1992)
Richards Island	69°13'	134°18'	(Dallimore and Wolfe, 1988)
Richardson Mtns.	68°05'	135°39'	(Lacelle et al., 2004)
Yukon Coastal Plain	69°37'	139°11'	(Fritz et al., 2011; Pollard, 1990)
Yukon Coastal Plain	69°34'	138°57'	(Pollard, 1990)
Yukon Coastal Plain	69°03'	137°47'	(French and Harry, 1990; Harry et al., 1988)
Ellesmere Island	79°58'	84°28'	Robinson and Pollard 1988
Ellesmere Island	79°55'	84°15'	(Pollard, 2000)
Unspecified origin			
NE Baffin Island	71°32'	79°34'	(Roujanski et al., 2010)

Table S4. Initial segregated ice value for surficial materials. The values represent high (50), medium (20), low (10), and no (0) abundance.

	Surficial material unit	Initial value
1	HC: Hummocky Terrain (coarse)	10
2	HF: Hummocky Terrain (fine)	20
3	TvC: Till veneer (coarse)	5
4	TvF: Till veneer (fine)	10
5	TbC: Till blanket (coarse)	10
6	TbF: Till blanket (fine)	20
7	ThC: Till hummocky (coarse)	10
8	ThF: Till hummocky (fine)	20
9	TmC: Till moraine (coarse)	10
10	TmF: Till moraine (fine)	20
11	O: Organic undifferentiated	20
12	E: Eolian undifferentiated	0
13	Cv: Colluvial veneer	5
14	C: Colluvial undifferentiated	10
15	A: Alluvial undifferentiated	20
16	Ln: Lacustrine littoral and nearshore	20
17	Lo: Lacustrine offshore	50
18	Mn: Marine littoral and nearshore	10
19	Mv: Marine veneer	10
20	Mo: Marine offshore	50
21	GLn: Glaciolacustrine littoral and nearshore	20
22	GLo: Glaciolacustrine offshore	50
23	GFp: Glaciofluvial outwash plain	0
24	GFc: Glaciofluvial ice contact	0
25	Wv: Weathered regolith veneer	5
26	W: Weathered regolith undifferentiated	10
27	R: Bedrock undifferentiated	0

Notes: The initial values are highest in offshore (i.e. fine-grained silt and clay) lacustrine, glaciolacustrine and marine units (GLo, Lo; Mo), where permafrost likely aggraded into water-saturated sediment. Values are medium in alluvial (A), nearshore and littoral lacustrine (Ln) and glaciolacustrine (GLn) units, and in fine-grained hummocky till (ThF), till blanket (TbF), till moraine (TmF), and hummocky terrain (HF) units, since these deposits may include significant fines fractions. Undifferentiated organic material (O) is assigned a medium value, as these units commonly overlie frost-susceptible mineral soils. The values are low for undifferentiated colluvial sediments (C), marine littoral and nearshore sediments (Mn), thick (undifferentiated) weathered regolith (W), and coarse-grained tills (ThC, TbC, TmC, HC) since these materials typically contain a limited fines fraction (Fulton, 1989; Geological Survey of Canada, 2014). The values are also low for marine veneer (Mv) and fine-grained till veneer (TvF) given the limited thickness of the deposits. The values are low for coarse-grained till veneer (TvC), colluvial veneer (Cv), and weathered regolith veneer (Wv) as these include coarse clasts. Segregated ice is considered absent in coarse-grained sands and gravels, including glaciofluvial outwash plains (GFp), ice contact sediments (GFc), eolian sands (E), and in bedrock (R).

Table S5. Initial segregated ice values (Table S4) and biome-modified values. HT = herb tundra, ST = shrub tundra, AT = alpine tundra, FT = forest tundra, BF = boreal forest. The biome distributions are from (Dyke et al., 2004). The values represent high (50), medium (20), low (10), and no (0) abundance.

	Surficial material unit	**Initial value**	**Biome-modified values**			
			HT	*ST, AT*	*FT*	*BF and others*
1	HC: Hummocky Terrain (coarse)	10	10	10	10	5
2	HF: Hummocky Terrain (fine)	20	20	20	20	10
3	TvC: Till veneer (coarse)	5	5	5	5	0
4	TvF: Till veneer (fine)	10	10	10	10	5
5	TbC: Till blanket (coarse)	10	10	10	10	5
6	TbF: Till blanket (fine)	20	20	20	20	10
7	ThC: Till hummocky (coarse)	10	10	10	10	5
8	ThF: Till hummocky (fine)	20	20	20	20	10
9	TmC: Till moraine (coarse)	10	10	10	10	5
10	TmF: Till moraine (fine)	20	20	20	20	10
11	O: Organic undifferentiated	20	20	20	20	10
12	E: Eolian undifferentiated	0	0	0	0	0
13	Cv: Colluvial veneer	5	5	5	5	0
14	C: Colluvial undifferentiated	10	10	10	5	0
15	A: Alluvial undifferentiated	20	20	20	20	10
16	Ln: Lacustrine littoral and nearshore	20	20	20	20	10
17	Lo: Lacustrine offshore	50	50	50	50	20
18	Mn: Marine littoral and nearshore	10	10	10	10	5
19	Mv: Marine veneer	10	10	10	10	5
20	Mo: Marine offshore	50	50	50	50	20
21	GLn: Glaciolacustrine littoral and nearshore	20	20	20	20	10
22	GLo: Glaciolacustrine offshore	50	50	50	50	20
23	GFp: Glaciofluvial outwash plain	0	0	0	0	0
24	GFc: Glaciofluvial ice contact	0	0	0	0	0
25	Wv: Weathered regolith veneer	5	5	5	5	0
26	W: Weathered regolith undifferentiated	10	10	10	5	0
27	R: Bedrock undifferentiated	0	0	0	0	0

Notes: The initial segregated ice value assigned to each pixel is iteratively modified based on the distribution of biomes in the 14 time steps since deglaciation (Dyke et al., 2004). In all surficial materials, the segregated ice value is reduced when tundra or forest tundra shifts to boreal forest and other more temperate biomes, representing the decrease in ground ice content due to increases in active-layer thickness in warmer periods. A reduction in ground ice content may accompany the establishment of forest due to (1) forest fires, which significantly increase active-layer thickness (Mackay, 1995), and (2) warmer climate that leads to deeper thaw, such as during the Holocene climatic optimum in the western Arctic (Burn, 1988). The segregated ice values are reduced in transitions from tundra biomes to forest tundra in coarse-grained regolith and colluvium, since permafrost is less likely to exist in these deposits in warmer climates (Jorgenson et al., 2008). If boreal forest subsequently transitions to tundra biomes, segregated ice values increase, representing millennial-scale ice aggradation during climatic cooling and resulting active-layer thinning.

Table S6. Segregated ice value multipliers for modern permafrost zones (Heginbottom et al., 1995). C = continuous, E = extensive discontinuous, S = sporadic discontinuous, I = isolated, NP = no permafrost.

	Surficial material	**Permafrost zone**				
		C	*E*	*S*	*I*	*NP*
1	HC: Hummocky Terrain (coarse)	1	1	0.4	0	0
2	HF: Hummocky Terrain (fine)	1	1	0.4	0.2	0
3	TvC: Till veneer (coarse)	1	1	0.4	0	0
4	TvF: Till veneer (fine)	1	1	0.4	0.2	0
5	TbC: Till blanket (coarse)	1	1	0.4	0	0
6	TbF: Till blanket (fine)	1	1	0.4	0.2	0
7	ThC: Till hummocky (coarse)	1	1	0.4	0	0
8	ThF: Till hummocky (fine)	1	1	0.4	0.2	0
9	TmC: Till moraine (coarse)	1	1	0.4	0	0
10	TmF: Till moraine (fine)	1	1	0.4	0.2	0
11	O: Organic undifferentiated	1	1	0.4	0.2	0
12	E: Eolian undifferentiated	1	0	0	0	0
13	Cv: Colluvial veneer	1	1	0.4	0	0
14	C: Colluvial undifferentiated	1	1	0.4	0	0
15	A: Alluvial undifferentiated	1	1	0.4	0.2	0
16	Ln: Lacustrine littoral and nearshore	1	1	0.4	0.2	0
17	Lo: Lacustrine offshore	1	1	0.4	0.2	0
18	Mn: Marine littoral and nearshore	1	1	0.4	0	0
19	Mv: Marine veneer	1	1	0.4	0	0
20	Mo: Marine offshore	1	1	0.4	0.2	0
21	GLn: Glaciolacustrine littoral and nearshore	1	1	0.4	0.2	0
22	GLo: Glaciolacustrine offshore	1	1	0.4	0.2	0
23	GFp: Glaciofluvial outwash plain	1	0	0	0	0
24	GFc: Glaciofluvial ice contact	1	0	0	0	0
25	Wv: Weathered regolith veneer	1	1	0.4	0	0
26	W:Weathered regolith undifferentiated	1	1	0.4	0	0
27	R: Bedrock undifferentiated	1	0	0	0	0

Notes: Segregated ice values are modified by the modern permafrost distribution using simple multipliers that maintain or reduce the biome-modified values. Values remain the same in the continuous and extensive discontinuous permafrost zones in most surficial materials. Coarse-grained eolian (E) and glaciofluvial (GFc; GFp) units decline to zero outside of continuous permafrost, representing preferential thaw of permafrost in these materials. Values for other surficial units are reduced in the sporadic and again in the isolated discontinuous zones to represent the reduction in areal extent of permafrost, and thus ground ice abundance. Thin and coarse-grained units (HC; TvC; TbC; ThC; TmC; Cv; C; Mn; Mv; Wv; W) decline to zero in the isolated permafrost zone, whereas thicker and finer-grained units retain negligible abundance.

Table S7. Count values for wedge ice accumulation for the surficial materials in different biomes. HT = herb tundra, ST = shrub tundra, AT = alpine tundra, FT = forest tundra, BF = boreal forest.

	Surficial material unit	Biome count value			
		HT	ST, AT	FT	BF and others
1	HC: Hummocky Terrain (coarse)	3	2	1	0
2	HF: Hummocky Terrain (fine)	4	3	2	0
3	TvC: Till veneer (coarse)	1	1	0	0
4	TvF: Till veneer (fine)	2	1	0	0
5	TbC: Till blanket (coarse)	3	2	1	0
6	TbF: Till blanket (fine)	4	3	2	0
7	ThC: Till hummocky (coarse)	3	2	1	0
8	ThF: Till hummocky (fine)	4	3	2	0
9	TmC: Till moraine (coarse)	3	2	1	0
10	TmF: Till moraine (fine)	4	3	2	0
11	O: Organic undifferentiated	4	3	2	0
12	E: Eolian undifferentiated	3	2	1	0
13	Cv: Colluvial veneer	1	1	0	0
14	C: Colluvial undifferentiated	2	1	0	0
15	A: Alluvial undifferentiated	3	2	1	0
16	Ln: Lacustrine littoral and nearshore	4	3	2	0
17	Lo: Lacustrine offshore	4	3	2	0
18	Mn: Marine littoral and nearshore	3	2	1	0
19	Mv: Marine veneer	3	2	1	0
20	Mo: Marine offshore	4	3	2	0
21	GLn: Glaciolacustrine littoral and nearshore	4	3	2	0
22	GLo: Glaciolacustrine offshore	4	3	2	0
23	GFp: Glaciofluvial outwash plain	3	2	1	0
24	GFc: Glaciofluvial ice contact	3	2	1	0
25	Wv: Weathered regolith veneer	1	1	0	0
26	W: Weathered regolith undifferentiated	2	1	0	0
27	R: Bedrock undifferentiated	0	0	0	0

Notes: These values represent relative wedge ice accumulation at each of the 14 time steps from 14 ka BP to 1 ka BP. The values are highest for herb tundra, moderate in shrub and alpine tundra, low in forest tundra, and nil in boreal forest and all other biomes. The values are also lower in coarse-grained materials, which are unlikely to include a significant surface organic layer that helps promote thermal contraction cracking, and in thin till and colluvial veneers, which are commonly underlain by bedrock. The count values accumulate iteratively over the 14 time steps. The count resets to zero when an area is lake or marine inundated. Areas lying under retreating ice sheets or glacial lakes remain at zero until they are subaerially exposed. The maximum accumulated value (56) represents an area that remained in herb tundra for all time steps.

Table S8. Wedge ice value multipliers for modern permafrost zones (after Heginbottom et al. 1995). The summed biome count values are multiplied by 1 (no melt) or 0 (complete melt). Values are generally based on associations between permafrost presence/absence in different surficial materials (e.g., Jorgenson et al., 2008). C = continuous, E = extensive discontinuous, S = sporadic discontinuous, I = isolated, NP = no permafrost.

	Surficial Material	**Permafrost zones**				
		C	*E*	*S*	*I*	*NP*
1	HC: Hummocky Terrain (coarse)	1	1	1	0	0
2	HF: Hummocky Terrain (fine)	1	1	1	0	0
3	TvC: Till veneer (coarse)	1	1	0	0	0
4	TvF: Till veneer (fine)	1	1	1	0	0
5	TbC: Till blanket (coarse)	1	1	1	0	0
6	TbF: Till blanket (fine)	1	1	1	0	0
7	ThC: Till hummocky (coarse)	1	1	1	0	0
8	ThF: Till hummocky (fine)	1	1	1	0	0
9	TmC: Till moraine (coarse)	1	1	1	0	0
10	TmF: Till moraine (fine)	1	1	1	0	0
11	O: Organic undifferentiated	1	1	1	1	0
12	E: Eolian undifferentiated	1	0	0	0	0
13	Cv: Colluvial veneer	1	1	0	0	0
14	C: Colluvial undifferentiated	1	1	1	0	0
15	A: Alluvial undifferentiated	1	1	1	0	0
16	Ln: Lacustrine littoral and nearshore	1	1	1	0	0
17	Lo: Lacustrine offshore	1	1	1	1	0
18	Mn: Marine littoral and nearshore	1	1	1	0	0
19	Mv: Marine veneer	1	1	1	0	0
20	Mo: Marine offshore	1	1	1	1	0
21	GLn: Glaciolacustrine littoral and nearshore	1	1	1	0	0
22	GLo: Glaciolacustrine offshore	1	1	1	1	0
23	GFp: Glaciofluvial outwash plain	1	0	0	0	0
24	GFc: Glaciofluvial ice contact	1	0	0	0	0
25	Wv: Weathered regolith veneer	1	1	0	0	0
26	W: Weathered regolith undifferentiated	1	1	1	0	0
27	R: Bedrock undifferentiated	0	0	0	0	0

Notes: The modern permafrost distribution (Heginbottom et al., 1995) is used to represent differential melt of wedge ice in surficial material units. In general, wedge ice is considered to melt in thin, coarse-grained sediments in the discontinuous permafrost zone, where higher thermal conductivity of the materials promotes thicker active layers or the thaw of permafrost. Thick till units, which may be overlain by insulating surface organic material in lowlands, maintain wedge ice in the extensive and sporadic discontinuous permafrost zones. Fine-grained offshore marine and lacustrine units and organic deposits also maintain wedge ice in the isolated permafrost zone. The accumulated biome count values modified by the permafrost zonation are classified into relative wedge ice abundance (high, medium, low, negligible, and none) using the quantile method (Table S9).

Table S9. Classification of count sum into relative wedge ice abundance using the quantile method.

Count	**Wedge ice abundance**
56 – 44	High
43 – 28	Medium
27 – 14	Low
13 – 1	Negligible
0	None

Burn, C. R.: The development of near-surface ground ice during the Holocene at sites near Mayo, Yukon Territory, Canada, J. Quat. Sci., 3(1), 31–38, doi:10.1002/jqs.3390030106, 1988.

Burn, C. R.: Cryostratigraphy, paleogeography, and climate change during the early Holocene warm interval, western Arctic coast, Canada, Can. J. Earth Sci., 34(7), 912–925, doi:10.1139/e17-076, 1997.

Coulombe, S., Fortier, D., Shur, Y. L., Kanevskiy, M. and Lacelle, D.: Cryofacies and cryostructures of massive ice found on Bylot Island, Nunavut, in Proceedings, 68th Canadian Geotechnical Conference and 7th Canadian Permafrost Conference, pp. 1–8, Canadian Geotechnical Society, Richmond, BC, Canada., 2015.

Dallimore, S. R. and Wolfe, S. A.: Massive ground ice associated with glaciofluvial sediments, Richards Island, NWT, Canada, in Proceedings of the 5th International Conference on Permafrost, pp. 132–138, Tapir, Trondheim, Norway., 1988.

Dyke, A. S. and Savelle, J. M.: Major end moraines of Younger Dryas age on Wollaston Peninsula, Victoria Island, Canadian Arctic: implications for paleoclimate and for formation of hummocky moraine, Can. J. Earth Sci., 37(4), 601–619, doi:10.1139/e99-118, 2000.

Dyke, A. S., Giroux, D. and Robertson, L.: Paleovegetation maps of northern North America, 18 000 to 1000 BP, Open File 4682, Geological Survey of Canada, Ottawa, ON, Canada., 2004.

Evans, D. J. A.: Glacial Landsystems, Arnold, London, UK., 2003.

Evans, D. J. A.: Controlled moraines: origins, characteristics and palaeoglaciological implications, Quat. Sci. Rev., 28(3–4), 183–208, doi:10.1016/j.quascirev.2008.10.024, 2009.

French, H. M. and Harry, D. G.: Nature and origin of ground ice, Sandhills Moraine, southwest Banks Island, Western Canadian Arctic, J. Quat. Sci., 3(1), 19–30, doi:10.1002/jqs.3390030105, 1988.

French, H. M. and Harry, D. G.: Observations on buried glacier ice and massive segregated ice, western Arctic coast, Canada, Permafr. Periglac. Process., 1(1), 31–43, doi:10.1002/ppp.3430010105, 1990.

Fritz, M., Wetterich, S., Meyer, H., Schirrmeister, L., Lantuit, H. and Pollard, W. H.: Origin and characteristics of massive ground ice on Herschel Island (western Canadian Arctic) as revealed by stable water isotope and Hydrochemical signatures, Permafr. Periglac. Process., 22(1), 26–38, doi:10.1002/ppp.714, 2011.

Fulton, R. J.: Quaternary geology of the Canadian interior plains, in Quaternary Geology of Canada and Greenland; by Fulton, R. J. (ed.); Geology of Canada Series no. 1, Geological Survey of Canada, Ottawa, ON, Canada., 1989.

Geological Survey of Canada: Surficial geology of Canada, Canadian Geoscience Map 195, Scale 1:5,000,000, Natural Resources Canada, Ottawa, ON, Canada., 2014.

Gowan, R. J. and Dallimore, S. R.: Ground ice associated with granular deposits in the Tuktoyaktuk Coastlands area, NWT, in Proceedings of the 5th Canadian Permafrost Conference, Collection Nordicana, vol. 54, pp. 283–290, Centre d'études nordiques, Université Laval, Québec City, Canada., 1990.

Harry, D. G., French, H. M. and Pollard, W. H.: Massive ground ice and ice-cored terrain near Sabine Point, Yukon Coastal Plain, Can. J. Earth Sci., 25(11), 1846–1856, doi:10.1139/e88-174, 1988.

Heginbottom, J. A., Dubreuil, M.-A. and Harker, P. A. C.: Permafrost - Canada, National Atlas of Canada MCR 4177, Scale 1:7,500,000, Department of Energy, Mines and Resources Canada., 1995.

Hyatt, J. A., Michel, F. A. and Gilbert, R.: Recognition of subglacial regelation ice near Pangnirtung, Baffin Island, Canada, in Proceedings of the 8th International Conference on Permafrost, vol. 1, pp. 443–448, Balkema, Zurich, Switzerland., 2003.

Jorgenson, M. T., Yoshikawa, K., Kanevskiy, M., Shur, Y. L., Romanovsky, V. E., Marchenko, S., Grosse, G., Brown, J. and Jones, B.: Permafrost characteristics of Alaska, in Proceedings of the 9th International Conference on Permafrost, vol. 29, pp. 121–122, University of Alaska, Fairbanks, USA., 2008.

Lacelle, D., Bjornson, J., Lauriol, B., Clark, I. D. and Troutet, Y.: Segregated-intrusive ice of subglacial meltwater origin in retrogressive thaw flow headwalls, Richardson Mountains, NWT, Canada, Quat. Sci. Rev., 23(5–6), 681–696, doi:10.1016/j.quascirev.2003.09.005, 2004.

Lacelle, D., Lauriol, B., Clark, I. D., Cardyn, R. and Zdanowicz, C.: Nature and origin of a Pleistocene-age massive ground-ice body exposed in the Chapman Lake moraine Complex, central Yukon Territory, Canada, Quat. Res., 68(02), 249–260, doi:10.1016/j.yqres.2007.05.002, 2007.

Lakeman, T. R. and England, J. H.: Paleoglaciological insights from the age and morphology of the Jesse moraine belt, western Canadian Arctic, Quat. Sci. Rev., 47, 82–100, doi:https://doi.org/10.1016/j.quascirev.2012.04.018, 2012.

Lorrain, R. D. and Demeur, P.: Isotopic evidence for relic Pleistocene glacier ice on Victoria Island, Canadian Arctic Archipelago, Arct. Alp. Res., 17(1), 89, doi:10.2307/1550964, 1985.

Mackay, J. R.: Active layer changes (1968 to 1993) following the forest-tundra fire near Inuvik, N.W.T., Canada, Arct. Alp. Res., 27(4), 323, doi:10.2307/1552025, 1995.

Mackay, J. R. and Dallimore, S. R.: Massive ice of the Tuktoyaktuk area, western Arctic coast, Canada, Can. J. Earth Sci., 29(6), 1235–1249, doi:10.1139/e92-099, 1992.

Murton, J. B.: Ground-ice stratigraphy and formation at North Head, Tuktoyaktuk Coastlands, western Arctic Canada: a product of glacier-permafrost interactions, Permafr. Periglac. Process., 16(1), 31–50, doi:10.1002/ppp.513, 2005.

Murton, J. B., Whiteman, C. A., Waller, R. I., Pollard, W. H., Clark, I. D. and Dallimore, S. R.: Basal ice facies and supraglacial melt-out till of the Laurentide Ice Sheet, Tuktoyaktuk Coastlands, western Arctic Canada, Quat. Sci. Rev., 24(5–6), 681–708, doi:https://doi.org/10.1016/j.quascirev.2004.06.008, 2005.

Pollard, W. H.: The nature and origin of ground ice in the Herschel Island area, Yukon Territory, in Proceedings of the 5th Canadian Permafrost Conference, Collection Nordicana, pp. 23–30, Centre d'études nordiques, Université Laval, Québec City, Canada., 1990.

Pollard, W. H.: Distribution and characterization of ground ice on Fosheim Peninsula, Ellesmere Island, Nunavut, in Environmental response to climate change in the Canadian High Arctic; by Garneau, M (ed.); Alt, B T (ed.); Bulletin 529, pp. 207–233, Geological Survey of Canada, Ottawa, ON, Canada., 2000.

Prest, V. K., Grant, D. R. and Rampton, V. N.: Glacial map of Canada, "A" Series Map 1253A, Scale 1:5,000,000, Geological Survey of Canada, Ottawa, ON, Canada., 1968.

Rampton, V. N.: Origin of massive ground ice on Tuktoyaktuk Peninsula, Northwest Territories, Canada: a review of stratigraphic and geomorphic evidence, in Proceedings of the 5th International Conference on Permafrost, vol. 1, pp. 850–855, Tapir, Trondheim, Norway., 1988.

Roujanski, V. E., Jones, K. W., Haley, J., Hawton, K. and Fitzpatrick, C.: Some Permafrost-Related Terrain Features and Associated Design Considerations along the Proposed Southern Rail Alignment, Mary River Project, in Proceedings of the 63rd Canadian Geotechnical Conference, Canadian Geotechnical Society, Richmond, BC, Canada, Calargy, AB, Canada., 2010.

Sharpe, D. R.: Late Glacial landforms of Wollaston Peninsula, Victoria Island, Northwest Territories: product of ice-marginal retreat, surge, and mass stagnation, Can. J. Earth Sci., 25(2), 262–279, doi:10.1139/e88-029, 1988.

St-Onge, D. A. and McMartin, I.: Quaternary geology of the Inman River area, Northwest Territories, Bulletin 446, Geological Survey of Canada, Ottawa, ON, Canada., 1995.

Stuiver, M., Reimer, P. J. and Reimer, R. W.: CALIB 71 [online] Available from: http://calib.org (Accessed 7 September 2018), 2018.

Wheeler, J. O., Hoffman, P. F., Card, K. D., Davidson, A., Sanford, B. V., Okulitch, A. V. and Roest, W. R.: Geological map of Canada, "A" Series Map 1860A, Scale 1:5,000,000, Natural Resources Canada, Ottawa, ON, Canada., 1996.

Wolfe, S. A.: Massive ice associated with glaciolacustrine delta sediments, Slave Geological Province, NWT, Canada, in Proceedings of the 7th International Permafrost Conference, Collection Nordicana, vol. 57, Centre d'études nordiques, Université Laval, Québec City, Canada., 1998.

Wolfe, S. A., Kerr, D. E. and Morse, P. D.: Slave Geological Province: An Archetype of Glaciated Shield Terrain, in Landscapes and Landforms of Western Canada; by Slaymaker O. (ed.), pp. 77–86, Springer, Switzerland., 2017.